NOTE

This manual documents the Model 2180A and its assemblies at the revision levels shown in Appendix 7A. If your instrument contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies, or the backdating sheet in Appendix 7A for older assemblies.

2180A
Digital Thermometer

Instruction Manual

P/N 489211
June 1978
Rev. 1 6/79

FLUKE®

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify the JOHN FLUKE MFG. CO., INC., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data, or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should ba made via United Parcel Service or "Best Way"* prepaid. Tha instrument ahould be shipped in the original packing carton; or if it is not availabla, usa any suitable container that is rigid and of adequate size. If a substitute container is used, tha instrument should be wrapped in paper and surrounded with at least four inchas of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspactad immediately upon original delivery to purchaser. All material in the container should be checked against tha enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC, will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

Rev. 6/81

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 2180A Digital Thermometer is a portable, five digit RTD thermometer. Temperature measurements are possible, depending on RTD type employed, over a range of -219°C to +664°C (-394°F to +1435°F) with 0.1° or .01° resolution. The instrument features:

1. Front Panel switch selection of Fahrenheit or Celsius readings.
2. Switch selectable RTD inputs.
3. Switch selectable input line voltage.
4. Dual slope measurement techniques.
5. Digital linearization of the RTD inputs.

1-3. DESCRIPTION

1-4. The instrument display features seven, high-intensity, seven segment LEDs, and leading zero suppression. Six of the LEDs are used to display numeric data, with a minus sign for negative temperature readings. The remaining LED displays the selected temperature scale character (°F or °C).

1-5. A four connection, screw-type terminal block is provided on the removable Input PCB for RTD connections. Input switch settings on this module will determine the microcomputer program necessary to linearize the desired RTD's input. A precision, four-wire resistance measurement of the RTD is routed through this module to the thermometer's input circuitry.

1-6. Selection of the temperature scale for display is made with a front panel pushbutton. The scale selected, Celsius or Fahrenheit, is displayed as the last character in the temperature reading (°C or °F). A scale change can be made at any time, and has no effect on calibration of the instrument.

1-7. Options and accessories available for the 2180A are listed in Table 1-1. More information concerning tbese items is given in Section 6 of this manual, Option and Accessory Information.

1-8. The measurement range of the 2180A Digital Thermometer is determined by the type of RTD used as the input device. RTD Types and total instrument accuracy specifications are listed in Table 1-2. Linearization of the RTD input is accomplished through toggling of the input switch segments on the RTD Input Module. Switch positions, numbers and applications are printed on the removable module beside the switch.

1-9. Four input line voltages are available for switch selection. Selection may be made for 100, 120, 220 or 240 volts ±10% as required to meet local conditions. Frequency may vary between 50 and 440 Hertz for all voltage selections. Refer to Section 4 of this manual when changing the selected input line voltage.

1-10. SPECIFICATIONS

1-11. Specifications for the 2180A Digital Thermometer are given in Table 1-3.

Table 1-1. 2180A Options and Accessories

DESIGNATION	DESCRIPTION
21X0A-002	Output Option
21X0A-006	Limits Option
Y2000	Multipoint Selector, RTD
Y2002	Alarms Output
Y2009	Battery Pack, 12V Rechargeable
Y2010	Rack Panel PTI, single, A size (for Y2000)
Y2011	Rack Panel PTI, double, A size (for Y2000)
Y2012	Rack Panel PTI, single, B size (for Y2009)
Y2013	Rack Panel PTI, double, B size (for Y2009)
Y2014	Rack Panel PTI, single, C size (for 2180A and Y2002)
Y2015	Rack Panel PTI, double, C size (for 2180A and Y2002)
Y2018	Panel Mount PTI-DIN, A size (for Y2000)
Y2019	Panel Mount PTI-DIN, B size (for Y2009)
Y2020	Panel Mount PTI-DIN, C size (for 2180A and Y2002)
Y2022	Divider, Thermometer Calibration
Y2023	Accessory Case
Y2024	3-Module Power Cord
Y2025	Probe, RTD, 100Ω, 385 Pf
Y2026	Cable, Output Unit, RS-232-C

Table 1-2. RTD Total Instrument Accuracy Specifications

RTD TYPE	RESOLUTION	APPLICABLE PORTION OF TEMPERATURE RANGE		MAXIMUM ERROR*					
				± DEGREES C			± DEGREES F		
		°C	°F	AT CAL	90 DAYS 20° to 30°	1 YEAR 15° to 35°	AT CAL	90 DAYS 68° to 86°	1 YEAR 59° to 95°
100Ω 385 Pt	.01°	−220 to 0	−364 to 32	.160	.204	.229	.288	.367	.412
		0 to 204	32 to 399.2	.052	.093	.119	.094	.167	.214
	.1°	−220 to 0	−364 to 32	.280	.300	.320	.600	.540	.680
		0 to 779	32 to 1434.2	.400	.509	.557	.720	.920	1.000
100Ω 390 Pt	.01°	−229 to 0	−380.2 to 32	0.095	0.141	0.166	0.155	0.235	0.281
		0 to 204	32 to 399.2	0.095	0.136	0.162	0.155	0.239	0.285
	.1°	−229 to 0	−380.2 to 32	0.140	0.161	0.181	0.200	0.249	0.290
		0 to 773	32 to 1423.4	0.140	0.247	0.296	0.200	0.429	0.521
100Ω 3902 Pt	.01°	−218 to 0	−360.4 to 32	0.020	0.064	0.089	0.035	0.112	0.158
		0 to 204	32 to 399.2	0.020	0.061	0.087	0.035	0.119	0.165
	.1°	−218 to 0	−360.4 to 32	0.140	0.160	0.180	0.200	0.246	0.287
		0 to 771	32 to 1419.8	0.140	0.247	0.295	0.200	0.429	0.520

Table 1-2. RTD Total Instrument Accuracy Specifications (cont)

RTD TYPE	RESOLUTION	APPLICABLE PORTION OF TEMPERATURE RANGE		MAXIMUM ERROR*					
				± DEGREES C			±DEGREES F		
		°C	°F	AT CAL	90 DAYS 20° to 30°	1 YEAR 15° to 35°	AT CAL	90 DAYS 68° to 86°	1 YEAR 59° to 95°
100Ω 392 Pt	.01°	−237 to 0	−394.6 to 32	0.080	0.127	0.153	0.140	0.223	0.269
		0 to 204	32 to 399.2	0.080	0.121	0.147	0.140	0.224	0.270
	.1°	−237 to 0	−394.6 to 32	0.140	0.162	0.182	0.200	0.251	0.292
		0 to 767	32 to 1412.6	0.140	0.246	0.294	0.200	0.427	0.518
100Ω 617 Ni	.01°	−60 to 0	−76 to 32	0.095	0.118	0.142	0.155	0.198	0.242
		0 to 93	32 to 199.4	0.095	0.121	0.145	0.155	0.209	0.253
	.1°	−60 to 0	−76 to 32	0.140	0.147	0.162	0.200	0.219	0.255
		0 to 177	32 to 350.6	0.140	0.155	0.173	0.200	0.245	0.285
120Ω 6721 Ni	.01°	−57 to 0	−70.6 to 32	0.095	0.118	0.142	0.155	0.197	0.242
		0 to 177	32 to 350.6	0.095	0.121	0.145	0.155	0.209	0.253
	.1°	−57 to 0	−70.6 to 32	0.140	0.147	0.162	0.200	0.219	0.254
		0 to 177	32 to 350.6	0.140	0.155	0.173	0.200	0.245	0.285

* *Maximum error depends on the temperature measured and the resolution used. Of the four temperature ranges presented for each RTD, the first two represent .01° resolution.*

Table 1-3. General Specifications

DIMENSIONS 10.49 cm H x 20.45 cm W x 32.64 cm D (4.13 in H x 8.05 in W x 12.85 in D)	**RELATIVE HUMIDITY** ≤80%, non-condensing, 0 to 50°C
WEIGHT 2.1 kg (4 lbs. 9 oz.)	**SHOCK AND VIBRATION** Meets MIL-T-28800 specifications
OPERATING POWER 12V dc or 100, 120, 220, 240V ac ±10%, selectable 50 to 400 Hz; 8W typical, 14W max.	**INPUT CONNECTION** 4-wire to screw terminal block
WARM-UP to RATED ACCURACY 5 minutes	**INPUT IMPEDANCE** 1000 Mohms at DC
STORAGE TEMPERATURE −40°C to +75°C (storage for Y2009 is 0 to 40°C)	**STABILITY** ±175 ppm in 90 days, ±200 ppm per year
OPERATING TEMPERATURE 0 to 50°C (Y2009: 0 to 40°C)	**TEMPERATURE COEFFICIENT** ±15 ppm/°C from 25°C

Table 1-3. General Specifications (cont)

ACCURACY vs WIRE LENGTH
No lead resistance error 4-wire RTD's if R_2 adjustment on the RTD Input Module is used. Otherwise, 0.04°C/Ω resistance of any one input lead if R_2 is not adjusted.

DISPLAY
°F or °C, switch-selectable, 7-segment LEDs 1.1 cm high

RESOLUTION
0.01° below 204°C for platinum RTD's, automatically shifting to 0.1° above 204°C (93°C for nickel RTD's). If readings are decreasing, shift is at 77°C for platinum, 66°C for nickel.

MEASUREMENT METHOD
Dual slope integration, under microcomputer control. 100 ms integration period, three readings per second. A/D Resolution is 100,000 counts at full-scale.

LINEARIZATION TECHNIQUES
Computer algorithm, 4th order curve fit.

COMMON MODE REJECTION
≥160 dB at DC, 50, 60, and 400 Hz ±0.1% with 100Ω unbalance at inputs.

RTD EXCITATION CURRENT
Nominal 0.5 mA.

COMMON MODE VOLTAGE
350V dc, 250V ac rms max.

NORMAL MODE REJECTION
≥90 dB at DC, 50, 60, and 400 Hz ±0.1%.

RESPONSE TIME
1 second typical.

ZERO DRIFT
Automatic zero correction.

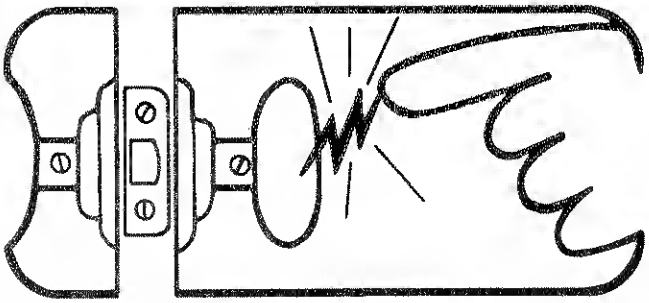
RTD TYPES
100Ω 385 Pt (DIN), 390 Pt, 3902 Pt, 392 Pt, 100Ω Ni (DIN), 120Ω Ni, or 0 to 1000Ω resistance, selectable via switch located on the input module.

VOLTAGE RANGE (CALIBRATION ONLY)
No annunciator or decimal point.
99999 μV full scale (switch S2 in AUTO), resolution 1 μV
999990 μV full scale (switch S2 in .1), resolution 10 μV

static awareness

A Message From

John Fluke Mfg. Co., Inc.

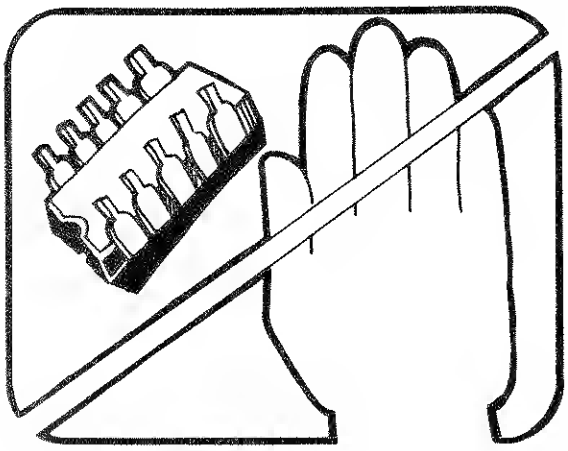


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

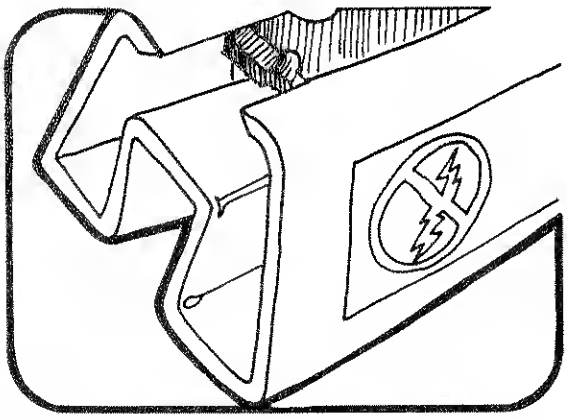
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

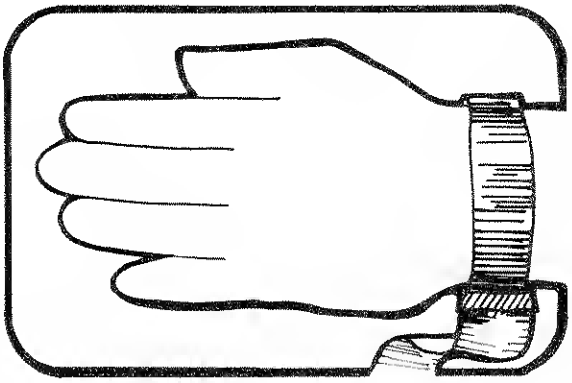
The following practices should be followed to minimize damage to S.S. devices.



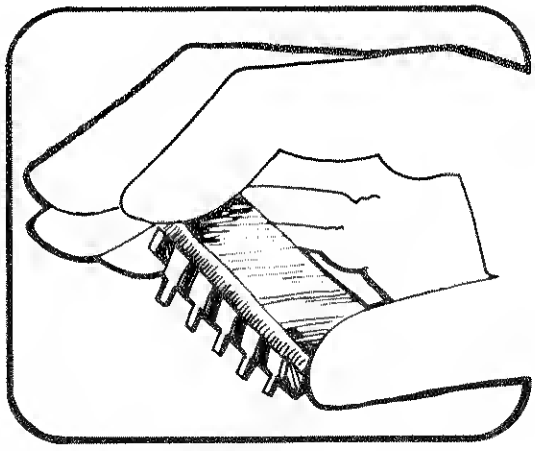
1. MINIMIZE HANDLING



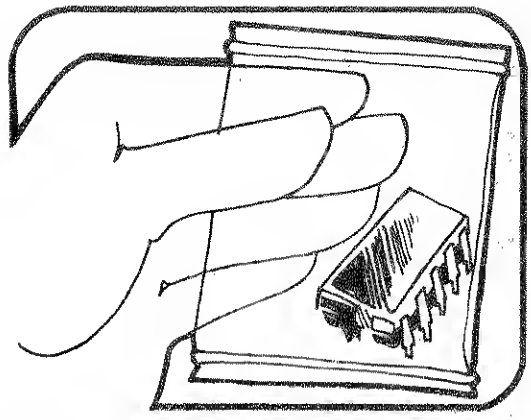
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



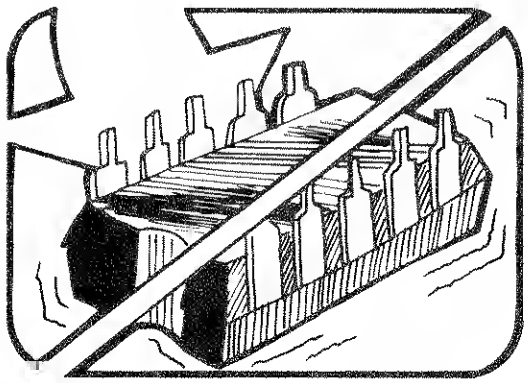
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



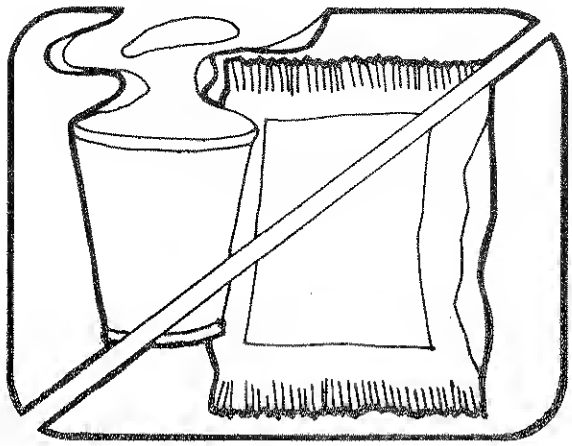
4. HANDLE S.S. DEVICES BY THE BODY



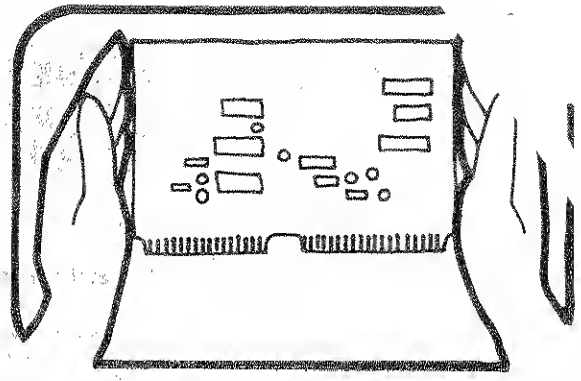
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



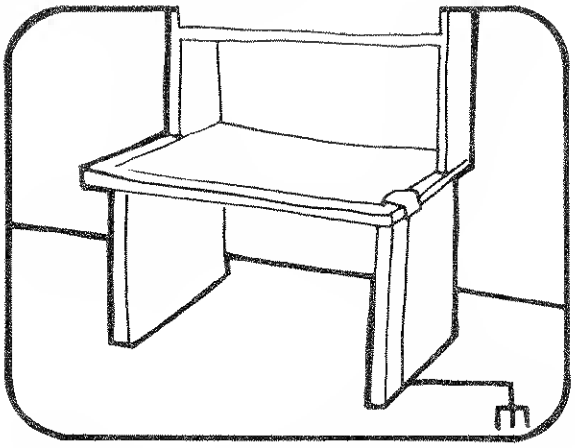
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR USUALLY PROVIDES COMPLETE PROTECTION TO INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Description
453522	6" X 8" Bag
453530	8" X 12" Bag
453548	16" X 24" Bag
454025	12" X 15" Bag
Pink Poly Sheet 30"x60"x60 Mil P/N RC-AS-1200 $20.00	Wrist Strap P/N TL6-60 $7.00

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Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the 2180A Digital Thermometer. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, please contact your nearest Fluke Technical Service Center, or the John Fluke Mfg. Co., Inc.; P.O. Box 43210; Mountlake Terrace, WA 98043; Tel (206) 774-2211. A list of Technical Service Centers is located in Section 7 of the manual.

2-3. SHIPPING INFORMATION

2-4. The 2180A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included on the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 2180A will operate at any of four switch selected input line voltages, all of which operate at frequencies from 50 to 440 Hertz. Before connecting the 2180A to the local ac line, verify that the present setting of the instrument matches the local line voltage. A decal on the instrument rear panel defines the original setting required for operation. Refer to Section 4 of this manual for instructions on verifying or changing the input line voltage switch settings.

2-8. The rear panel ac input connector is a three-prong, U-ground connector which permits the instrument to be connected, via the power cord, to the applicable line voltage. The offset prong on this connector is attached to the 2180A power supply, and should be connected through the power cord to a high quality earth ground.

2-9. The 2180A will also operate on 12V dc power. A rear panel terminal block, with screw tightened connections, (TB1), allows for ease of attachment. Actual input voltage may vary from 11 to 15V dc; most 12V dc power supplies capable of supplying 1A (e.g., a car battery) can be utilized.

2-10. INSTALLATION

2-11. The 2180A is contained in a special molded plastic instrument case. Other associated accessories used with the 2180A will be packaged in similar PTI (Portable Test Instrument) cases varying only in size. The cases are, in all other respects, compatible and can be stacked vertically and latched together to form miniature portable test systems. Instrument stacks should be limited to a total of 40 pounds.

2-12. Use the following procedure when attaching PTI cases to each other:

1. For the top case, pull out latches found on either side of the instrument.
2. Nestle top and bottom cases together.
3. Push latches in to secure units together.

2-13. Prepare the 2180A for operation by plugging the input line power cord into the applicable power source or connecting the external input connector to an external 12V dc source.

2-14. OPERATING FEATURES

2-15. The location of the 2180A controls, indicators, and connectors is shown and described in Figure 2-1 and Table 2-1 respectively.

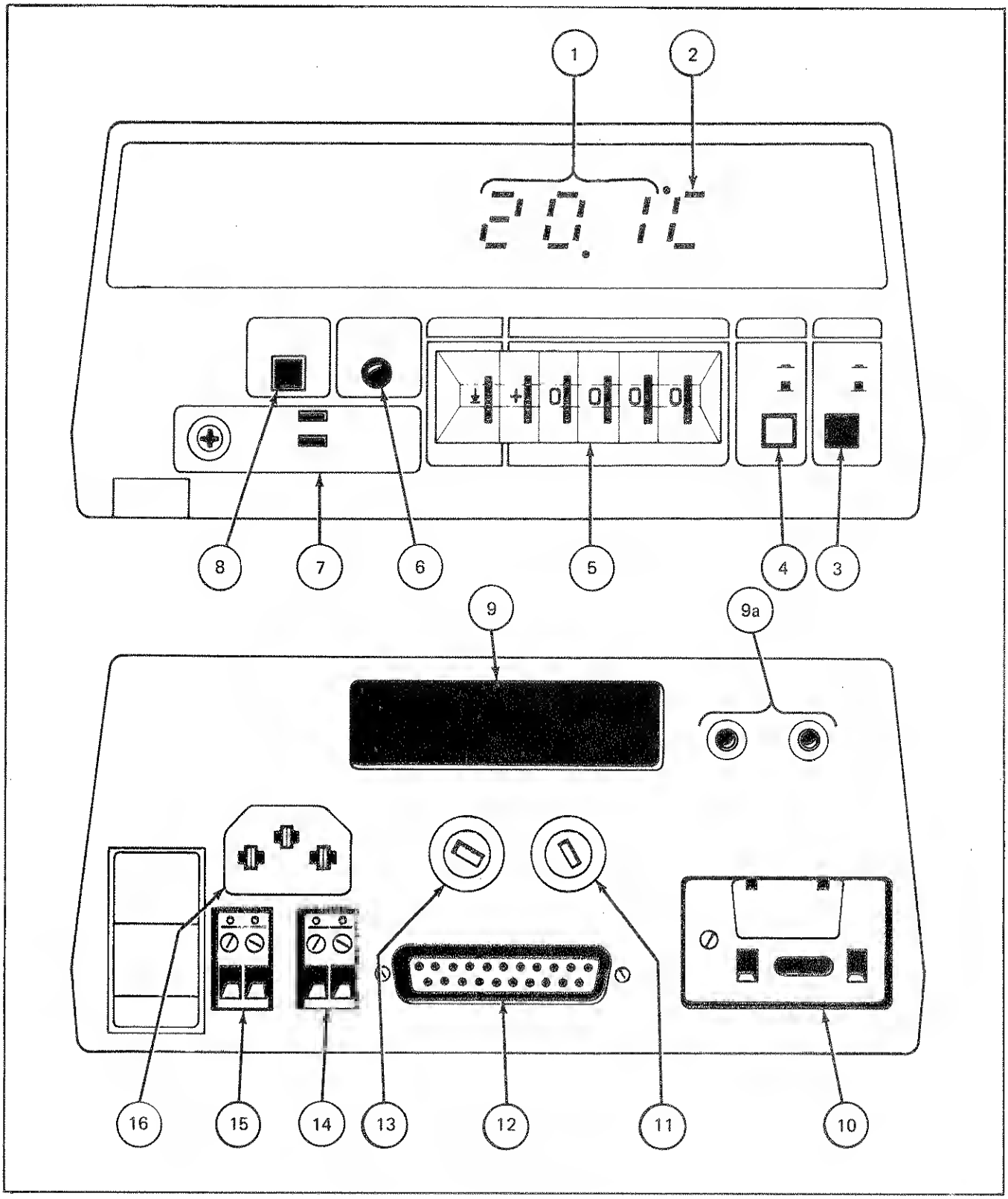

Figure 2-1. Controls, Indicators and Connectors

Table 2-1. Controls, Indicators and Connectors

REF	NAME	FUNCTION
1	Digital Display	Displays a five digit readout of the measured input temperature. Leading zero suppression and a variable position decimal point are included. A minus sign is displayed for negative temperature measurements. Flashes when overranged.
2	Temperature Scale Indicator	Displays the temperature scale represented by the digital display data: °C or °F.
3	Power Switch	Push on/Push off.
4	SCALE	Selects the temperature scale for display: °C or °F.
5	LIMIT and FUNCTION	Part of the –006 Limits Option. When installed, the thumbwheels may be set to a four digit LIMIT value (+ or –). The FUNCTION thumbwheel can then be set to define the limit value and signal (LIMIT EXCEEDED) when the displayed temperature has exceeded the limit value (>, ⩽). Display will read the difference between the thumbwheel setting and the actual temperature when (△) is set in FUNCTION. Set FUNCTION thumbwheel for storage of maximum ($\overline{\uparrow}$) or minimum ($\underline{\downarrow}$) measured since last initializing (no limit value settings).
6	LIMIT EXCEEDED	Part of the –006 Limits Option. Indicator illuminates when the preset limits have been exceeded.
7	CALIBRATION COVER	Sliding cover for calibration adjustments.
8	INITIALIZE MAX/MIN	Part of the –006 Limits Option. Resets the previous maximum and minimum readings stored by the microcomputer.
9	DIGITAL OUTPUT	Connector for the ASCII coded data for the Output Unit, if Option -002 is installed.
9a	ANALOG OUTPUT	Banana jack connector for an Analog Output (1 mV per degree), if Option -002 is installed.
10	RTD INPUT MODULE	Removable module houses RTD input connections and type selection switch.
11	F2	External 12V dc input fuse (3/4A MDL slo-blo).
12	ACCESSORY CONNECTOR	Cable connector for accessory bus connection from accessory units.
13	F1	Input line power fuse 1/8A (100 or 120 VAC) 1/16A (220 or 240 VAC). MDL (slo-blo).
14	LIMITS	When the Limits Option is installed, it provides contact closure when the set limit has been exceeded.
15	±12 VDC	Input terminals for the external 12V dc power source.
16	LINE VOLTAGE CONNECTOR	Input connector for the input line voltage.

2-16. OPERATING NOTES

2-17. The following paragraphs describe various conditions that could affect operation of the thermometer. The operator should familiarize himself with these conditions prior to operating the 2180A.

2-18. Option Information

2-19. Supplementary operating instructions are necessary when operating the 2180A equipped with one of the available options. Detailed information regarding the operation of each available option is given in Section 6 of this manual, Option and Accessory Inforamtion.

2-20. Fuse Replacement

2-21. The ac line input and external dc input are individually fuse protected. Both fuses are readily accessible on the outside of the rear panel. The ac line input fuse (F1) should be replaced with a 1/8A MDL (slo-blo) fuse if either 100 or 120 volt operation has been selected. Use a 1/16A MDL (slo-blo) replacement for 220 or 240 volt operation. The external dc input (F2) requires a 3/4A MDL (slo-blo) fuse for a replacement.

CAUTION

Remove the power connector from the 2180A before changing fuses.

2-22. RTD Installation

2-23. Use the following procedure when installing an RTD and conducting temperature measurements:

1. Set POWER switch to OFF.

2. Remove the RTD Input Module from the instrument (rear panel).

3. Route the selected RTD lines through the Input Module's rear access port, and connect them to the input terminals; depending on the type of RTD, connections may involve 2, 3, or 4 wires. Refer to Figure 2-2 as a reference when connecting RTD lines to the Input Module (TB1). Lines of the same color usually go to the same polarity connections (+V and +S, or -V and -S). Refer to instructions included with the RTD for specific connection directions.

NOTE

When 2- or 3-wire RTDs are used, there is some error created due to the RTD excitation current in the Sense (S) wire leads. To minimize this error. The user should (when possible) use the 4-wire RTD connection as show in Figure 2-2.

4. On the Input Module, toggle the RTD Selector switch for the applicable position number shown in Table 2-2 or in the table printed on the pcb.

5. Slide the Input Module, RTD lines attached, back into the 2180A securely.

NOTE

Refer to Section 6 of this manual or applicable accessory manuals for instructions on the operation of any installed options or connected accessories.

6. Set POWER switch to ON.

7. Expose the RTD to a temperature within the RTD's specified range (see Specifications in Section 1).

8. The RTD temperature, in the scale selected, is displayed on the front panel.

9. Adjust R2 on the RTD Input Module to compensate for probe lead resistance. Refer to "RTD Input Module Adjustment" procedures in Section 4 of this manual. Adjustment must be performed whenever a different RTD probe is installed.

NOTE

When thhe RTD Input Selector Switch (S1) is set for Resistance, measurements greater than 196Ω cannot be made unless Autoranging is defeated. To do this, set S2 on the RTD Input Module for the ".1°" position. (See Table 2-3 for switch functions.)

2-24. OPERATING DIRECTIONS

2-25. Operate the 2180A Thermometer using the following procedure:

1. Verify the instrument has the correct RTD connected.

2. Connect the input line cord to the applicable power source.

3. Select the temperature scale desired for display by pressing the Front Panel SCALE switch (in for °C, and out for °F).

4. Set POWER switch to ON.

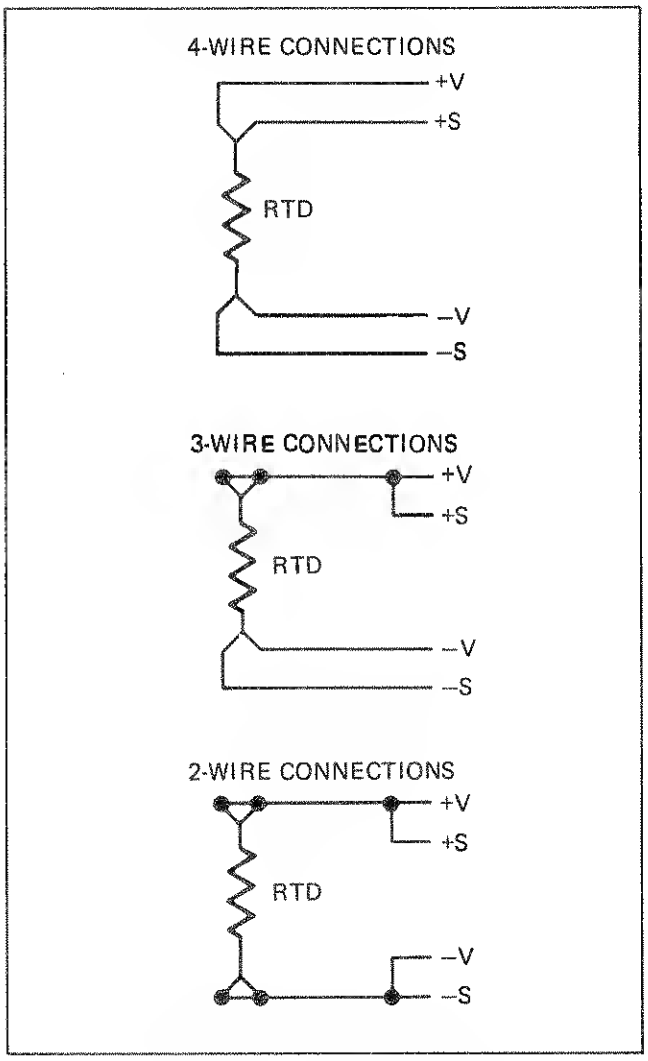

Figure 2-2. RTD Connections

2-26. Additional Features

2-27. The following paragraphs describe how the 2180A may be used to measure voltage or resistance. In both cases, the RTD will be replaced with a length of standard electrical wire. To connect the standard wire to the RTD Input Module, use steps 1-3 of the RTD Installation procedure, ignoring all reference to the RTD.

2-28. HOW TO MEASURE VOLTAGE

2-29. The 2180A can be used to measure positive voltages only up to +100 mV or +1V maximum in two ranges, with 1 μV or 10 μV resolution respectively. To obtain the desired range, refer to the following steps and Figure 2-3.

Table 2-2. RTD Input Module Switch Settings

POS #	RTD TYPE	SWITCH POSITION			
		1	2	4	8
0	385 Pt	0	0	0	0
1	390 Pt	1	0	0	0
2	3902 Pt	0	1	0	0
3	392 Pt	1	1	0	0
4	100 Ohm Ni	0	0	1	0
5	120 Ohm Ni	1	0	1	0
6	———				
7	———				
8	Resistance	0	0	0	1
9	CAL	1	0	0	1

Note: For switch segments 1, 2, 4 and 8: ON = 1, OFF = 0.

Table 2-3. RTD Input Module Switch Functions

SWITCH NO.	SWITCH POSITION	SWITCH FUNCTIONS
S1	0 - 5	Programs the microcomputer (μc) for each RTD probe type (See Table 2-2.)
	6, 7	NOT USED
	8	"RESISTANCE", programs the μc to read ohms.
	9	"CAL", programs the μc to read μV (bypasses the linearization program).
S2	.1	Causes the analog to digital converter circuitry (A/D) to have 10 μV input sensitivity and displays temperature to 0.1° resolution only.
	AUTO	Causes the A/D to automatically change from .01° to 0.1° resolution for overrange or 0.1° to .01° resolution for underrange.
S3	Scan	For future use only.
	Man	MUST BE LEFT IN THIS POSITION DURING NORMAL OPERATION.

NOTE

The decimal point and temperature scale indicator (°C/°F) should be ignored during the following steps, the user must be aware of the selected range.

2-30. 100 millivolt Range

1. Install lead wire to the RTD Input Module, refer to RTD Installation procedures, steps 1-3 (this section).

2. Set RTD Input Module switches, S1 to position 9 and S2 to AUTO.

3. Replace RTD Input Module and turn 2180A on.

4. The 2180A is now ready to measure positive voltages up to +100 mV.

2-31. 1 Volt Range

1. Install lead wire to the RTD Input Module, refer to RTD Installation procedures, steps 1-3 (this section).

2. Set RTD Input Module switches, S1 to position 9 and S2 to .1°.

3. Replace RTD Input Module and turn 2180A on.

4. The 2180A is now ready to measure positive voltages up to +1V.

2-32. HOW TO MEASURE RESISTANCE

2-33. The 2180A can be used to measure positive resistances up to 999.9Ω with 10 mΩ resolution (RTD excitation ≈0.5 mA). To set up the 2180A as a resistance measurement device, refer to the following steps and Figure 2-3.

NOTE

The temperature scale indicator (°C/°F) should be ignored during the following steps.

2-34. Resistance Measurements

1. Install lead wires to the RTD Input Module, refer to RTD Installation procedure, steps 1-3.

2. Set RTD Input Module switches, S1 to position 8 and S2 to .1°.

3. Connect a known resistance, less than 1 kΩ, to the wires connected to the RTD Input Module, and use the following steps to compensate for lead resistance.

4. Replace RTD Input Module and turn 2180A on.

5. Adjust R2 through the rear panel of the RTD's Input Module until the 2180A's display reads the same value as the known resistance.

6. Remove the known resistance, the 2180A is now calibrated and ready to measure positive resistances up to 999.9Ω.

NOTE

For measuring resistances of less than 196Ω, switch S2 on the RTD Input Module should be set to the AUTO position.

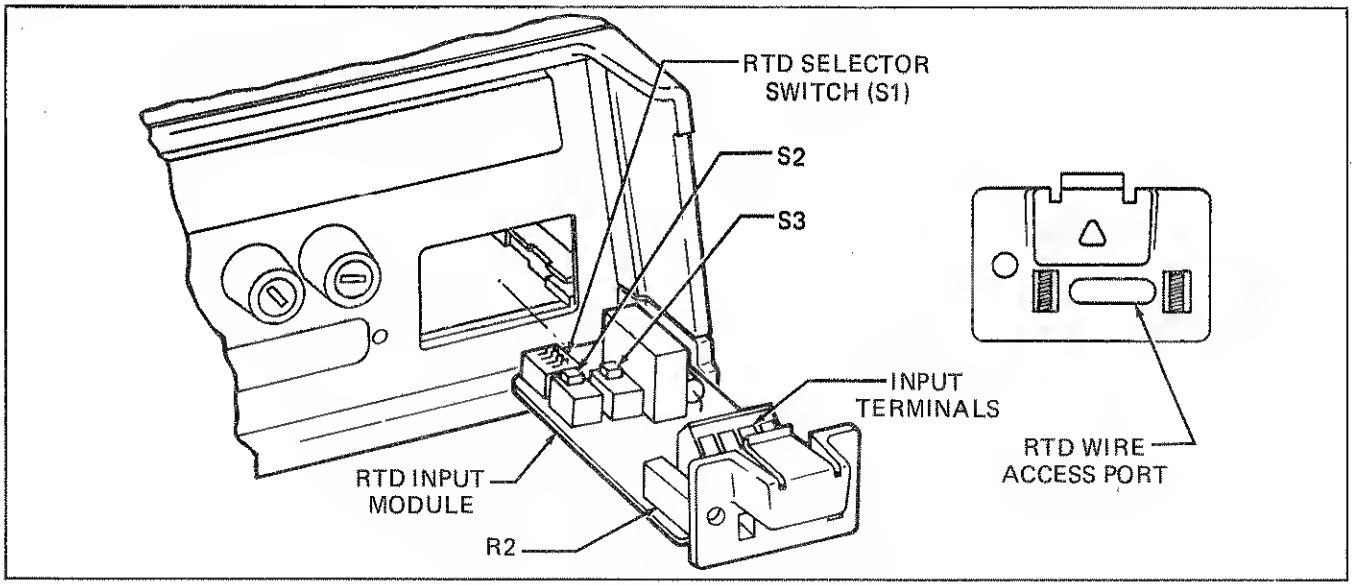

Figure 2-3. RTD Input Module Access

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual contains an overall functional description and a brief circuit analysis of the 2180A Digital Thermometer. Simplified circuit diagrams are provided, as necessary, to supplement the text. Detailed schematics are given in Section 8 of this manual.

3-3. The Model 2180A is a single point RTD Digital Thermometer with 0.1° and .01° resolution for either degrees F or C. This instrument features dual slope A/D conversion, microcomputer control logic, and a 5-digit display with temperature scale indicator. Various RTD types can be used over a temperature range of -394°F to 1435°F (-219°C to 664°C). Refer to Figure 3-1 for the following functional description. Mnemonic definitions are provided in Table 3-1.

3-4. FUNCTIONAL DESCRIPTION

3-5. The Model 2180A executes a continuous series of measurement cycles. These cycles, controlled entirely by a microcomputer, include three major periods: the Auto-Zero, the Integrate, and the Read periods. During each period, digital controls are applied to the analog section of a dual slope converter. The converter in turn generates a compare output. The configuration of the analog section during each phase of the measurement cycle is established by the condition of microcomputer controlled FET switches.

3-6. The measurement cycle begins with the Auto-Zero period. During this period, the input to the Buffer Amplifier is connected to ground througb an FET switch and the accumulated dc offset voltages present in the analog section are sampled and held by the Auto-Zero capacitor. This voltage is used later in the measurement cycle to cancel measurement errors introduced by offset voltages in the analog circuitry. The final measurement is therefore proportional to the RTD probe output voltage and does not include offset errors.

3-7. During the Integrate period, the RTD input voltage read across the RTD, is applied to the integrator. The algebraic sum of the AZ and RTD input voltages is integrated over a 100 ms period. At the end of this period, the RTD input voltage is removed from the integrator, and the Read period is started.

3-8. A reference voltage is applied to the integrator during the Read period, causing the integrator capacitor to be discharged at a linear rate. When the integrator output reaches zero, a compare signal is generated to end the Read period. The duration of the Read period is translated by the microcomputer, to provide a digital indication of the RTD temperature.

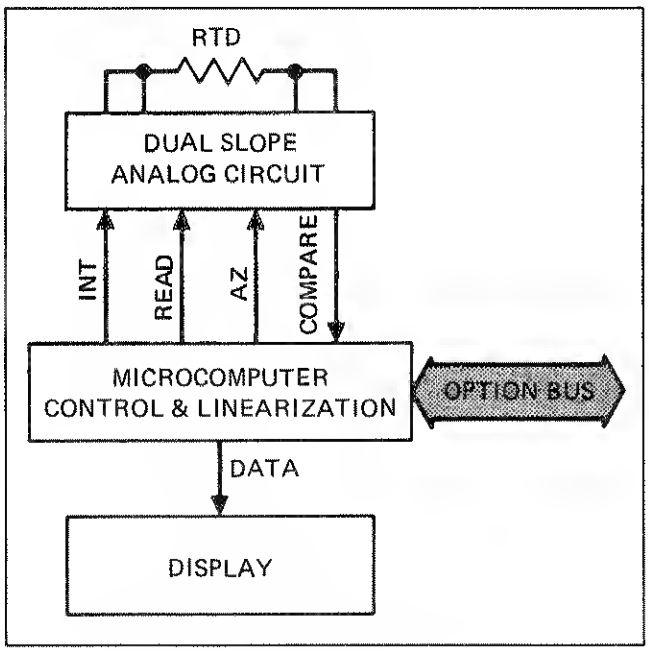

Figure 3-1. 2180A Simplified Block Diagram

Table 3-1. Mnemonics

ANALOG COM	Measurement common
AZ	Auto-Zero
CM	Compare input to the microcomputer
$\overline{\text{DATA}}$	Data on bus
$\overline{\text{DCLK}}$	Data clock
DE+	Positive read command
DE–	Negative read command
DIGITAL COM	–15V with respect to Analog Com
D.P./NEG	Drives decimal point, depending on reading end resolution
INT 1	Causes the unknown voltage to be integrated
$\overline{\text{LINEAR}}$	Used to command the microcomputer to display linear counts
$\overline{\text{WRT}}$	Write
$\overline{\text{WRT ADR}}$	Write address, signals that an address is being transmitted
X10	Selects a buffer gain of X10 (0.1° resolution)
X100	Selects a buffer gain of X100 (0.01° resolution)
△2	Hold command
+ SENSE	Voltage sense wires from RTD - no current flows in these wires
–SENSE	Voltage sense wires from RTD - no current flows in these wires
+Vm	An intermediate voltage - not used directly
–V	Current return

3-9. CIRCUIT ANALYSIS

3-10. Circuit analysis of the 2180A is discussed in two sections: digital and analog. The digital section is covered first; particular attention is paid to digital control of the analog section. The analysis of the analog section covers the analog measurement circuitry and the 2180A power supply.

3-11. Digital Section

3-12. The digital section of the 2180A consists of a single-chip microcomputer with a self-contained, programmed, read only memory (U9), a hex CMOS open drain buffer (U13), and an LED display. This section, shown in Figure 3-2, will provide the following functions:

1. Conversion of the non-linear RTD probe voltage, as measured by the analog section, into a linear digital display.

2. Control of the analog section.

3. Control of all accessories on the accessory bus.

3-13. The microcomputer (U9) contains all of the 2180A programming, control logic, and linearizing capability. It also provides all signals necessary to update the display. Linearization of the RTD signal is accomplished by using a piece-wise, 4th order, curve-fit approximation for each type of RTD. One of the seven operating programs is selected for the RTD type by setting S1 on the RTD Input Module. A table showing RTD switch setting numbers and corresponding RTD types is printed on the RTD Input Module PCB.

3-14. Measurement data is continuously strobed out of the microcomputer in decoded-seven-segment, bit-parallel, character-serial format. This data is then sent to the LED display.

3-15. The total measurement cycle takes 300 ms. The cycle consists of the following periods:

1. Auto-Zero period (100 to 200 ms).

2. Integrate period (100 ms). A 1 ms nominal hold signal is inserted at the beginning and end of the Integrate period to accomodate settling times in the analog section.

3. Read period (variable 0 to 100 ms).

3-16. Analog Section

3-17. ANALOG MEASUREMENT CIRCUIT

3-18. The analog measurement circuitry consists of an RTD input circuit, two voltage reference circuits, a ground sense amplifier, a buffer amplifier, a dual slope

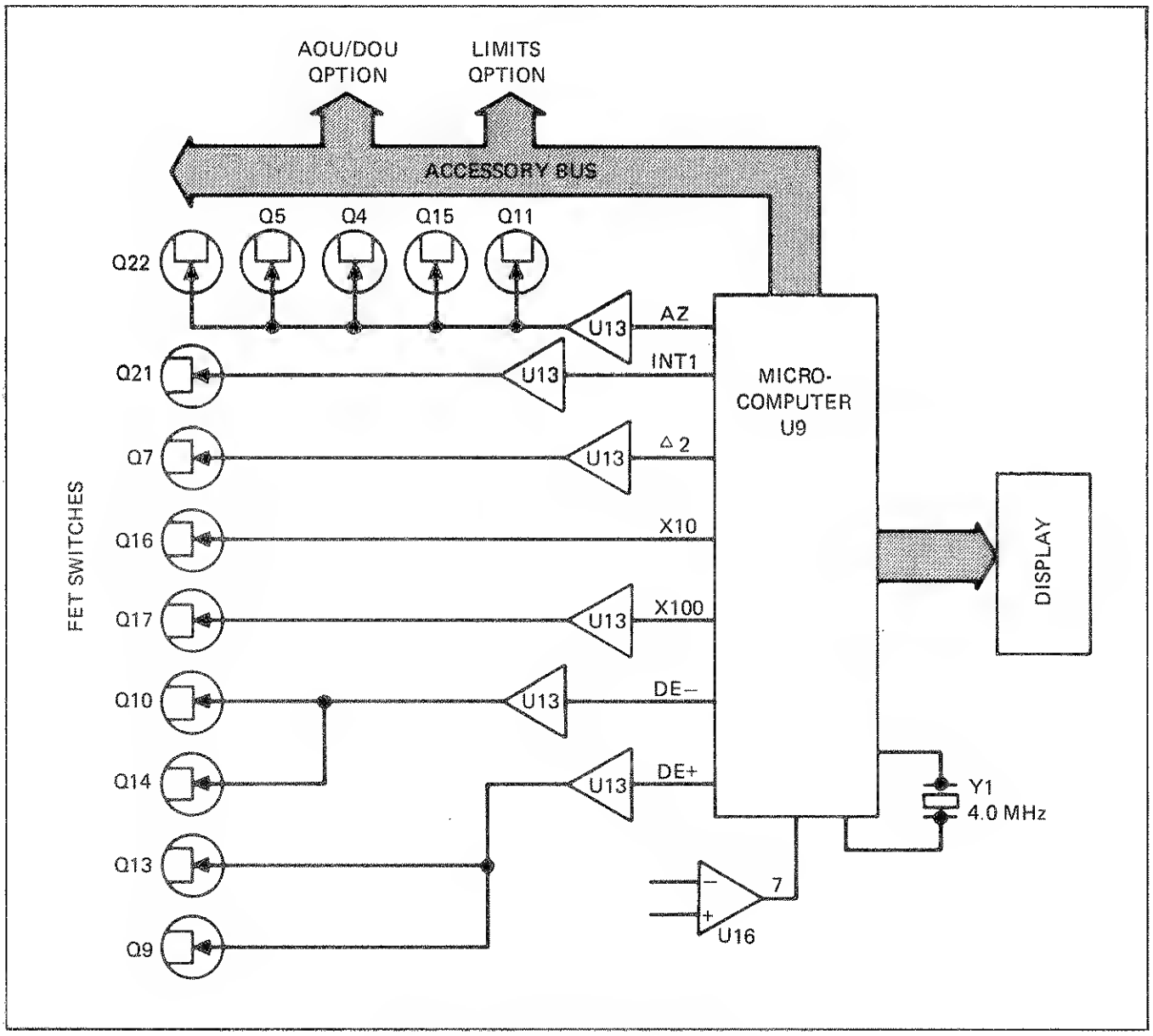

Figure 3-2. Simplified Schematic — Digital

A/D Converter (integrator, gain stage, and comparator), and a combination of FET switches. Refer to Figure 3-3 in conjunction with the following individual circuit descriptions. All FET switches will be shown in their open state; they are closed during measurement cycle commands from the 2180A's digital section.

3-19. The RTD Input circuit comprises the RTD probe, the RTD Input Module, and a low pass filter on the Input Module's PCB. Source current flows through a series combination of the RTD probe, R2 (RTD Input Module), and R1 (Main PCB). The voltage sensed across the RTD is routed through the Input Module, and onto the Main PCB. The +Sense line (always a positive voltage) is then applied to the low pass filter.

3-20. The ground sense amplifier (Q20, U7 and associated circuitry) maintains the -Sense line at measurement ground. This amplifier compensates for noise and offsets on the -V and -Sense lines.

3-21. To achieve switching between 0.01° and .1° resolution, the buffer gain is shifted by a factor of ten. For 0.01° resolution, FET switch Q17 is on, and a reference voltage of -100 mV is applied to the buffer (Q19, U5). The buffer gain is set to 100. For 0.1° resolution, FET switch Q16 is on, and a reference voltage of -1.00V is applied and the huffer gain is 10.

3-22. The first voltage reference consists of a resistor network supplied by an accurate 6.2V dc reference voltage. The resistive divider network is set to provide 200 mV to Q14, 100 mV to Q15, 1.0V to Q11,and 2.0V to Q10.

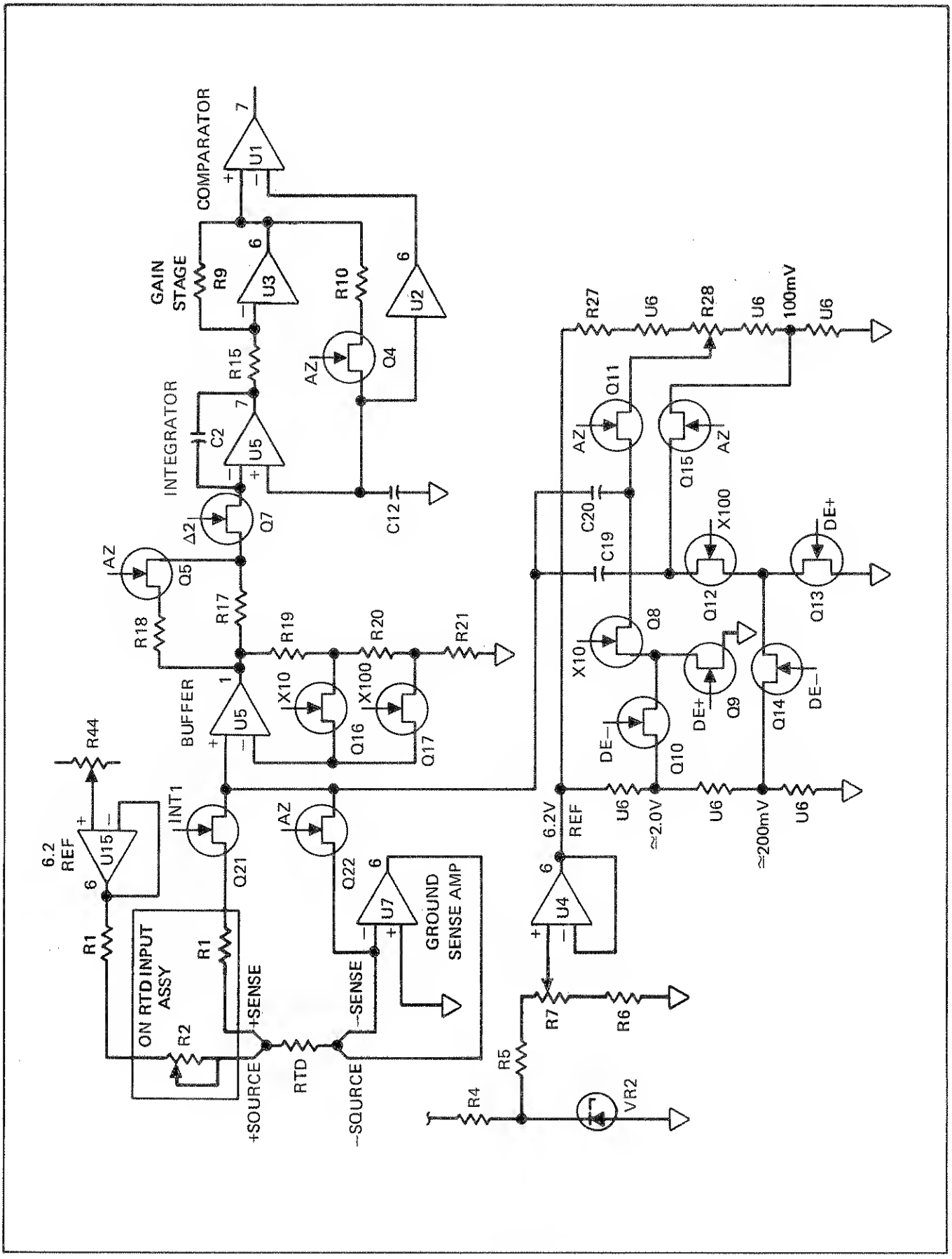

Figure 3-3. Simplified Schematic — Analog

When 0.01° resolution is in use, Q12 will allow reference capacitor C19 to attain a –100 mV charge. For 0.1° resolution, Q8 will allow C20 to charge to °1.0V. Either reference capacitor will be placed at the -Sense level during Auto-Zero. Recovery deintegrate is applied to Q10 and Q14.

3-23. A second voltage reference (U15-6) provides an accurate 6.2V across the series combination of R1 (Main Thermometer PCB), R2 (RTD Input PCB), and the RTD. This voltage therefore provides the source (+V) voltage for the RTD.

3-24. The Buffer, Integrator, Gain Stage, and Comparator Amplifiers combine to perform the analog functions of the Integrate, Read, and Auto-Zero periods. The Buffer is used to provide integrator inputs during all three periods. Tbe Integrator integrates the Buffer output voltage during the Integrate and Read periods and, in combination with the Gain Stage, functions as a closed-loop amplifier during the Auto-Zero period.

3-25. An Auto-Zero period is commanded during the first phase of each measurement cycle. During this time, five auto-zero switcbes (Q4, Q5, Q11, Q15, and Q22) are closed by the microcomputer. Three of the switches (Q11, Q15, and Q22) charge the reference capacitors to +100 mV on C19 and +1.0V on C20. Closing switch Q4 connects the Integrator and Gain Stage into a closed-loop configuration. This action also allows the Auto-Zero capacitor (C12) to charge to a value proportional to the algebraic sum of all the offset voltages in the Buffer, Integrator and Gain Stage. At the end of the Auto-Zero period, switches Q4, Q5, Q11, Q15, and Q22 are opened. The reference capacitors (C19 and C20) and the Auto-Zero capacitor retain their charges for later use in the measurement cycle.

3-26. The Integrate period (see Figure 4-4) starts on the leading edge of the integrate command from the microcomputer; switch Q21 is closed and switch Q7 is opened. The RTD input voltage is applied through switch Q21 to the Buffer input. After a 1 ms settling period, switch Q7 closes, and the Buffer output is applied to the Integrator for 100 ms. As the integrator capacitor C2 charges, the Integrator drives the comparator, through the gain stage to +5V dc which indicates that the charge on C2 is more negative than the Auto-Zero Reference C12. At the end of the Integrate period, the integrate capacitor is charged to a level and polarity proportional to the RTD voltage, and switches Q21 and Q7 return to the open state.

3-27. The Read period starts at the end of the Integrate period. Depending upon the input polarity sensed by the comparator during the Integrate period, one of two Read modes is enabled if a positive input is sensed, a positive Read mode is enabled. Similarly, a negative Read mode is enabled when a negative input is sensed.

3-28. When the positive Read mode is commanded, FET switches Q13 and Q9 are closed. If 0.1° resolution is in effect, Q8 will place the positive side of reference capacitor C20 at ground. With 0.01° resolution in effect, Q12 will place the positive side of reference capacitor C19 at ground. Reference capacitors C20 and C19 will then apply either –1.0V or –100 mV, respectively, to the Buffer input.

3-29. When the negative Read mode is commanded, switches Q10 and Q14 are closed; Q9 and Q13 are open. With .01° resolution selected, approximately +200 mV will be applied to the positive side of reference capacitor C19. The algebraic sum of the voltage at the Buffer input will then be +100 mV. When 0.1° resolution is selected, approximately +2.0V will be applied to the positive side of reference capacitor C20. Buffer input voltage will then be +1.0V (only during recover deintegrate).

3-30. After a 1 ms settling time, switch Q7 closes and the Buffer output voltage is applied to the Integrator input. The integrator capacitor now begins to discharge at a linear rate (determined by the reference voltage). This discharge continues until the integrator voltage reaches the comparator trip point, which is referenced to the voltage on the Auto-Zero capacitor. When this level is reached, the comparator changes state, commanding the microcomputer to terminate the Read period. To facilitate auto-zero, the microcomputer then calls a reference voltage opposite in polarity to the one previously used (DE– or DE+). When the integrator reaches the trip point, the microcomputer immediately begins the Auto-Zero period.

3-31. Offset voltages present during the Integrate and Read periods are cancelled by offset voltages that were sampled and held during the Auto-Zero period.

3-32. POWER SUPPLY

3-33. The 2190A Power Supply consists of a DC to DC Converter and regulating circuitry. AC inputs are made via the input power cord, line fuse, and power transformer/rectifier. External +12V dc inputs can also be made directly to the DC to DC Converter circuitry via line TB1 (see Main PCB schematic, Section 8). The function of the power supply is to provide +5V, +5V unregulated, +15V, and –15V dc operating voltages for the 2180A circuitry. The power supply can be driven from ac line or 12V dc external source. The DC to DC conversion and voltage regulation is accomplisbed using conventional power supply design techniques.

Section 4
Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual provides information about warranty, factory service, maintenance, performance testing, routine recalibration and recalibration after repair. The performance test is recommended when the instrument is received and later as a preventive maintenance tool or for testing after repair. The test verifies performance at several temperatures within the range of a given RTD type. Specifications are provided both for annual and for a more precise 90-day performance-testing cycle.

4-3. SERVICE INFORMATION

4-4. The instrument is warranted for a period of 1 year upon delivery to the original purchaser. The WARRANTY is located on the back of the title page of this manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of these service centers is included in Section 7 of this manual. If requested, an estimate will be provided to the customer before any work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Instrument Disassembly and Resassembly

4-8. Disassemble the thermometer using the following procedure (power cord disconnected):

1. Remove the RTD Input Module through its access port in the rear panel.

2. On the bottom of the instrument, remove the four securing screws. Lift the top cover free.

3. Remove the screw securing the center of the Main PCB to the bottom portion of the case.

4. Lift the Main PCB, complete with Front and Rear Panels, clear of the case.

5. Remove the Output Option, if installed and required, by removing the three screws connecting it to the Main PCB, disconnecting the interconnect cables at J1 and J3, and lifting the Output Option PCB clear.

6. Remove the Front Panel, if required, by disconnecting the guard screw at the lower right corner; disconnecting the Front Panel Interconnect cable at J6; disconnecting, if installed, the Limits Option interconnect cable at J4; and moving the Front Panel forward.

7. Remove the Rear Panel, if required, by removing the three screws attaching it to the Main PCB, disconnecting the wires from the input line power connector, unsoldering the wires from two fuse holders and moving the rear panel free.

8. Perform reassembly in the reverse order.

4-9. Input Power

4-10. Input line power voltage is selected by positioning the two switches on the right edge of the Main PCB. Each switch (S3 and S4) has a position identifying slot; Figure 4-1, shows these slots positioned for 120V ac operation. Table 4-1 lists the switch settings for other line voltages.

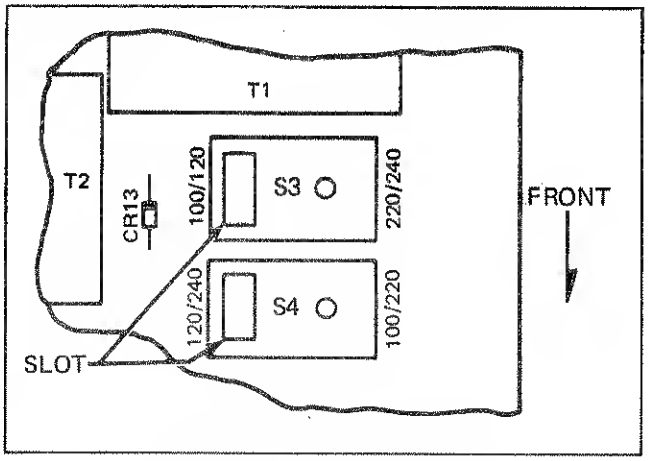

Figure 4-1. Line Voltage Selection

Table 4-1. Line Voltage Selection

VOLTAGE	S3 SLOT (REAR SW)	S4 SLOT (FRONT SW)
100	Left	Right
120	Left	Left
220	Right	Right
240	Right	Left

4-11. Cleaning

4-12. Clean the instrument periodically to remove dust, grease and other contamination. Use the following procedure:

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They will react with plastic materials used in the manufacture of the instrument.

1. Clean the front panel and case with a soft cloth dampened with a mild solution of detergent and water.

2. Clean the surface of the pcb using clean, dry air at low pressure (≤20 psi). If grease is encountered, spray with Freon T.F. Degreaser or anhydrous alcohol and remove grime with clean, dry air at low pressure.

4-13. Fuse Replacement

WARNING

DISCONNECT THE UNIT FROM LINE POWER BEFORE ATTEMPTING FUSE REPLACEMENT.

4-14. The 2180A has two fuses, both accessible on the rear panel. F1 is for the input line power and should be replaced, when necessary, with a 1/8A MDL (slo-blo) fuse when the input line power selected is 100V or 120V. When the input power selected is 220V or 240V, F1 should be replaced with a 1/16A MDL fuse. F2 is for the 12V dc external power and requires a 3/4A MDL fuse.

4-15. Service Tools

4-16. No special tools are required for maintenance or repair.

4-17. Static Discharge Precautions

4-18. Static discharge can damage components contained in the 2180A. The following precautions should be observed when conducting adjustments or repairs with the instrument's top cover removed.

1. Never conduct repairs without first pressing power OFF, disconnecting the line cord and accessory bus cable from the ACCESSORY CONNECTOR.

2. Perform all repairs at a static-free work station.

3. Minimize handling of ICs and the pcb; in no case handle them by their connectors.

4. Keep repair parts in their original container until ready for use.

5. Use static ground straps to discharge repair personnel.

6. Use conductive foam or anti-static containers to store replacement or removed ICs.

7. Remove all plastic, vinyl, and styrofoam products from the work area.

8. Do not slide static sensitive devices over any surface.

9. Use only anti-static type solder removal tools.

10. Use grounded tip soldering irons.

4-19. PERFORMANCE TEST

4-20. The Performance Test verifies instrument performance to specifications and may be used for initial acceptance, verifying calibration, or as an aid in troubleshooting. If the thermometer fails to meet specifications either the Calibration Adjust Procedure or Troubleshooting should be performed, as determined by qualified service personnel.

4-21. Table 4-2 lists the equipment required for the Performance Test and Calibration Adjustment Procedure. If the recommended model of test equipment is not available, a substitute that meets the minimum use specifications may be used. The test should be conducted with an ambient temperature of 25 ±2°C (77.0 ±3.6°F).

4-22. Use the following procedure for the Performance Test:

1. Set the POWER switch to OFF and remove the line power cord from the line voltage source.

2. On the RTD Input Module, position S1 to 9 and S2 to AUTO.

3. Connect the equipment as shown in Figure 4-2. Refer to Table 4-2 for Recommended Test Equipment.

4. Verify the POWER switch is OFF, then adjust the line voltage transformer for the nominal input line voltage.

5. Set the POWER switch to ON.

6. Allow the thermometer to stabilize (at least 5 minutes).

7. On the Decade Resistance Box, select 100.00Ω and adjust R2 on the RTD Input Module for a display of "51240" (equivalent to 0°C or 32°F).

8. Refer to that portion of Table 4-3 pertaining to the RTD(s) in use.

9. On the Decade Resistance Box, select the first resistance listed in Table 4-3 for the RTD type being verified.

10. On the RTD Input Module, set the selector switch for the RTD type to be verified (0-5). Refer to Table 2-2 for switch settings.

11. Verify that the 2180A reading is within the tolerance listed in Table 4-3 (90-day or 1-year).

12. Repeat steps 9, 10, and 11 for the remaining resistances listed for the RTD type being verified.

13. Repeat steps 9-12 for as many RTD types as necessary.

14. Set the line voltage transformer for line voltage minus ten percent and repeat the test for one RTD type.

15. Set the line voltage transformer for line voltage plus ten percent and repeat the tests for one RTD type.

16. Set the line voltage transformer for the input line voltage.

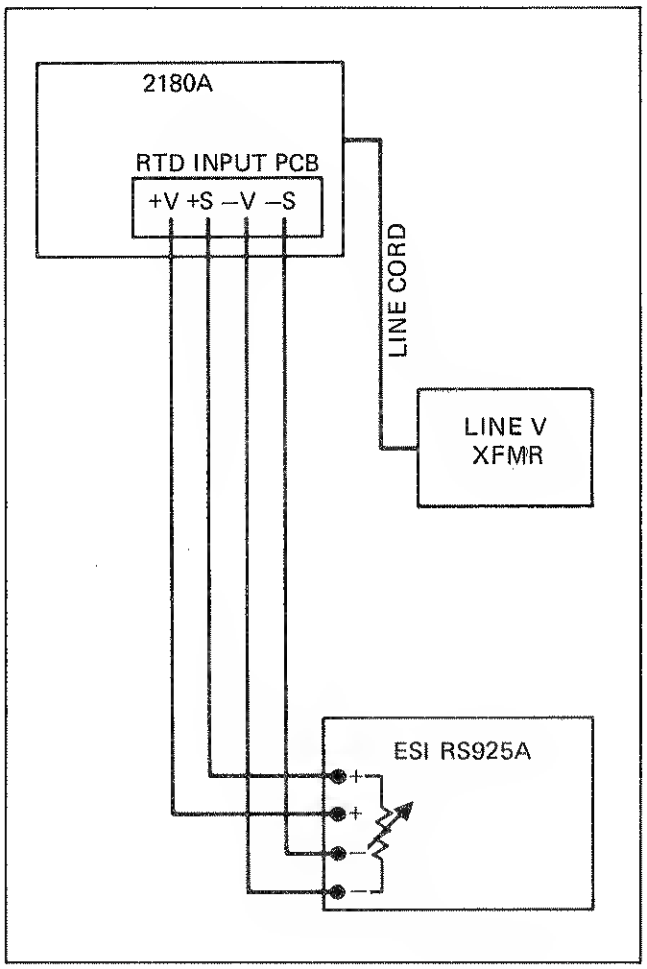

Figure 4-2. Performance Test Connections

Table 4-2. Recommended Test Equipment

TEST EQUIPMENT	MINIMUM USE SPECIFICATIONS	RECOMMENDED MODEL
Variable Line-Voltage Transformer	100, 120, 220, 240V ac, as required, ±10%	General Radio VARIAC W5HM
Decade Resistance 8ox	.01Ω resolution	General Radio 1433T, ESI Model RS925A, or equivalent.
Voltage Divider	100:1	Fluke Y2022 or equivalent
Calibrator (DC Source)	10 μV resolution	Fluke 343A or equivalent
Digital Voltmeter (±100 μV)	100 μV resolution, on 10V range	Fluke 8800A or equivalent
Lag 8ath	Temperature Stable, .01° resolution	Customer Constructed. (See Lag Bath Construction, this section)

Table 4-3. 2180A Performance Tests

Ω INPUT	SELECT SWITCH SETTING	READING		90-DAY TOLERANCE ±		1-YEAR TOLERANCE ±	
		°F	°C	°F	°C	°F	°C
100.00	(0)	32.00	0.00	*	*	*	*
18.53		−328.00	−200.00	0.346	0.192	0.355	0.197
204.88		536.0	280.0	0.395	0.221	0.407	0.226
345.21		1292.0	700.0	0.871	0.484	0.900	0.500
100.00	(1)	32.00	0.00	*	*	*	*
17.30		−328.00	−200.00	0.211	0.127	0.219	0.132
206.17		536.0	280.0	0.259	0.161	0.271	0.166
347.83		1292.0	700.0	0.385	0.224	0.417	0.240
100.00	(2)	32.00	0.00	*	*	*	*
16.99		−328.00	−200.00	0.091	0.052	0.099	0.117
206.29		536.0	280.0	0.259	0.161	0.271	0.166
316.54		1112.0	600.0	0.345	0.208	0.381	0.222
100.00	(3)	32.00	0.00	*	*	*	*
17.05		−328.00	−200.00	0.196	0.122	0.204	0.117
206.82		536.0	280.0	0.259	0.161	0.271	0.166
317.80		1112.0	600.0	0.354	0.208	0.381	0.222
100.00	(4)	−32.00	0.00	*	*	*	*
71.80		−67.00	−55.00	0.172	0.105	0.173	0.106
161.70		212.0	100.0	0.215	0.144	0.218	0.145
219.00		347.0	175.0	0.231	0.150	0.238	0.152
81.77	(5)	−70.00	−56.67	0.172	0.105	0.173	0.106
189.66		190.0	87.78	0.213	0.143	0.216	0.154
271.14		340.0	175.1	0.230	0.149	0.237	0.152

* Note: R2 on the RTD input card must be adjusted to give an indication of 32°F or 0°C with 100Ω input (See Step 7 of Performance Test).

4-23. CALIBRATION

4-24. The thermometer should be calibrated at either 90-day or annual periods, depending upon the accuracy desired, and any time that repairs are made to the instrument. Conversion between Fahrenheit and Celsius scales is realized through a mathematical computation by the microcomputer. Calibration in °F is recommended. Calibration in either scale (°F or °C) insures the accuracy of the other. Either scale can be verified by executing the Performance Test.

4-25. Equipment Preparation

4-26. Prepare the equipment for calibration using the following procedure:

1. Remove the top cover from the instrument.

2. Apply power to 2180A and all test equipment to be used. Insure the 2180A warm-up period has been sufficient to reach rated accuracy (at least 5 minutes).

3. Select the desired temperature scale (°C or °F). If the Limits Option is installed select the LIMITS ($\leqslant$ or $>$) function.

NOTE

Before removing the RTD Input Module, set power switch to OFF.

CAUTION

Do not connect analog common (0V) to digital common (-15V with respect to analog common). Instrument damage may result.

4-27. Reference Adjust

4-28. Perform Reference Adjust using the following procedure:

1. Connect the DVM between TP16 and TP1 (Analog Common).

2. Adjust R7 for a reading of 6.2V ±100 μV.

4-29. Reference Adjust (+V)

4-30. Perform the Reference Adjust for the +V using the following procedure:

1. Connect the DVM to TP17 (HI) and TP1 (LO - Analog Common).

2. Adjust R44 to obtain a reading of 6.2V ±100 μV.

4-31. Zero Adjust

4-32. Perform the Zero Adjust using the following procedure:

1. Connect the 2180A Digital Thermometer, DC Voltage Calibrator, and Voltage Divider as illustrated in Figure 4-3.

2. On the RTD Input Module, place a jumper between -V and -S on TB1. Select AUTO (S2 on the Input PCB).

3. Toggle the RTD the select switch for setting 9.

4. On the 2180A front panel, access calibration adjustments behind the cover in the lower left corner. Loosen the screw and slide the cover to the left.

5. Set the Calibrator output to 0.00102V (10.2 μV to 2180A). Note the 2180A reading. Now reverse the input polarity and again note the reading. Adjust R29 (access beneath front panel calibration cover - ZERO) until the readings in both directions are the same.

6. Adjust R14 (Main PCB) for a reading of +10. Reverse input polarity and look for a 2180A reading of -10. Repeat steps 4 and 5 if a reading of -10 is not obtained.

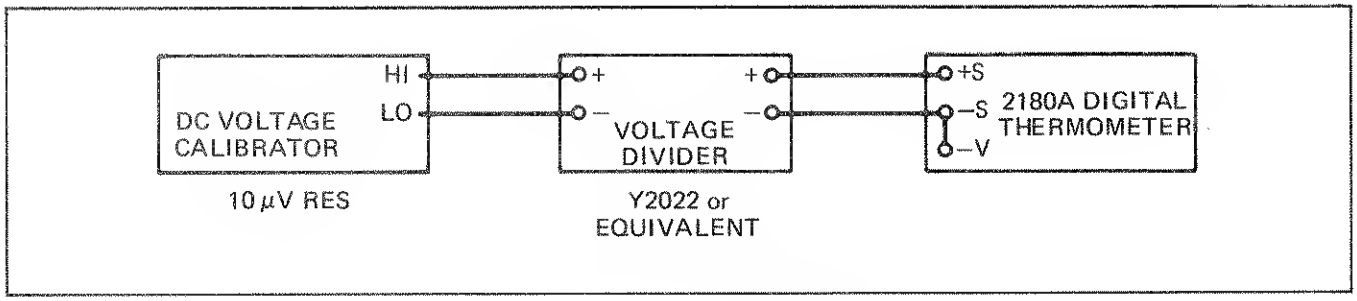

Figure 4-3. Calibration Connections

4-33. Resolution Adjustments

4-34. Use the following procedure to adjust the 2180A's .01° and .1° display and the verify autoranging operation.

1. Replace the 2180A's top cover. Leave test equipment connected (DC Voltage Calibrator, Voltage Divider) as described in Zero Adjust instructions.

2. On the 2180A front panel, access calibration adjustments by loosening the screw and sliding the cover to the left.

3. On the RTD Input Module, set S2 to AUTO. Set input switch S1 to setting 9 (CAL).

4. Set the DC Voltage Calibrator output to 9.9V (99 mV to the 2180A).

5. Adjust R27 (.01° cal potentiometer) for a reading of 99000 ±1.

6. Change the calibrator output to 99V (990 mV to 2180A) and position S2 out of AUTO.

7. Adjust R28 (.1° cal potentiometer) for a reading of 99000.

NOTE

If the Y2022 is being used, leave the calibrator output at 9.9V and change the Y2022 setting the 10.

8. Change the calibrator output to 45V. The 2180A should read 45000 (Y2022 in 100).

9. Change the calibrator output to 4.5V. Place S2 in AUTO position. The 2180A should read 45000.

4-35. RTD Input Module Adjustment

4-36. Use the following procedure whenever 2180A calibration or repair has been accomplished or when a different RTD probe is installed.

1. Connect the RTD probe to the RTD Input Module (TB1).

2. Select the applicable input switch setting (S1) and insert the probe into a lag bath. Refer to the following paragraph for a suggested method of constructing a lag bath.

3. Install the RTD Input Module in the 2180A. Apply power to the 2180A.

4. Adjust R2 (access through rear hole on RTD Input Module) until the 2180A displays the lag bath temperature.

5. Calibration of the 2180A is now complete. Disconnect all test equipment from the instrument.

4-37. Lag Bath Construction

4-38. The following instructions provide a recommended method of constructing a lag bath.

1. Required materials include:
   - Any RTD probe acceptable to the 2180A Digital Thermometer.
   - A mercury thermometer (.01° resolution). Princo Model ASTM 116C or equivalent for room temperatures (18.9° to 25.1°C).
   - Insulated jar (unbreakable inner envelope). Thermos or equivalent.

2. Drill two holes in the insulated jar's lid (or in some other suitable fitting). These holes should be just large enough to accept the mercury thermometer and the RTD probe.

3. With the jar containing water at room temperature, attach the lid, with RTD and mercury thermometer installed. The RTD should be immersed as far as possible without touching the bottom. The mercury thermometer should be immersed to the same water depth as the RTD.

4. Allow the temperature displayed on the digital thermometer to stabilize (usually 5 minutes).

5. Perform calibration.

4-39. SELECTED COMPONENT REPLACEMENT

4-40. Certain components in the two 6.2V reference supplies are supplied as a matched set. If a component in either set is replaced, all the components in that set must be replaced with a matched set supplied by John Fluke Mfg. Co., Inc. The two sets include R4, R5, and VR2 in the 6.2V reference and R43, R46, and VR5 in the 6.2V (V+) reference.

4-41. TROUBLESHOOTING

4-42. Troubleshooting for the 2180A consists of the tabular flow chart in Table 4-4. When a step on the flow chart is completed check for a decision transfer. If no decision is required perform the next step of the table in sequence. Refer to Figure 4-4 for test point location and Table 4-5 for test point identification.

CHANGE/ERRATA INFORMATION

ISSUE NO: 5 8/84

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The revision letter stamped on the indicated PCB is equal to or higher than that given with each change.
2. No revision letter is indicated at the beginning of the change/errata.

MANUAL

Title: 2180A
Print Date: June 1978
Rev.- Date: 1-6/79

C/E PAGE EFFECTIVITY

Page No.	Print Date
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CHANGE #1 - 12307
Rev.-E, A4 Output Option PCB Assembly (2180A-4020T)

On page 602-8, Table 602-5,
CHANGE: R19|RES,VAR,100 +/-10%,1/2W|275735|11236|360T101A|1
TO: R19|RES,VAR,CERMET,100 +/-10%,1/2W|285130|89536|285130|1

On page 602-10, Figure 606-2, and page 8-10, Figure 8-4, rotate R19 90 degrees to face the outer edge of the PCB.

CHANGE #2 - 12526

On page 5-3, Table 5-1,
Add "1" in the USE CODE column for reference designators H5, MP16, MP17, MP18, MP19, and MP20.

At the bottom of the page,
ADD: 1 If the handle on your case is secured by a rivet, these components are included in one assembly (C-size Cover Assy). Order John Fluke P/N 516703.

ERRATA #1

On page 1-2, Table 1-1,
DELETE: Y2025 | Probe, RTD, 100 ohm, 385 PT

On page 1-4, Table 1-3,
ADD: PROTECTION CLASS 1
Relates solely to insulation or grounding properties further defined in IEC 348.

CHANGE #3 - 12964
Rev.-F, A4 Output Option -002 PCB Assembly (2180A-4020T)

On page 602-7, Table 602-5,
CHANGE: 002|Output Option -002 PCB Assembly|-002|89536|2190A-002|REF
Figure 602-2 (2180A-4020T)

TO: A4|Output Option -002 PCB Assembly|-002|89536|2190A-002|REF
Figure 602-2 (2180A-4020T)

A4A1|O.U. Adapter Assembly|539288|89536|539288|1

Add Table 1 and Figure 1 to the end of page 602-10.

Table 1. A4A1 O.U. Adapter Assy

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFR SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY
A4A1	O.U. ADAPTER ASSY FIGURE 2. (2180A-4021)	539299	89536	539288	1	
Q1,3	TRANSISTOR,SI,NPN	218396	04713	2N904	2	
R1	RES,DEP,CAR,10K +5%,1/4W	348839	80031	CR251-1-5-10K	1	
U1	IC,C-MOS,DUAL,"D"-TYPE	340117	02735	CD4012AE	1	
U2	IC,C-MOS,HEX,INVERTER	404681	02735	CD4069BE	1	

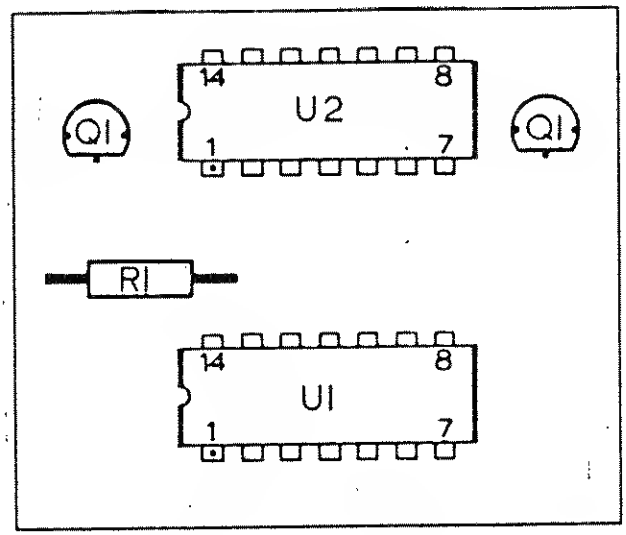
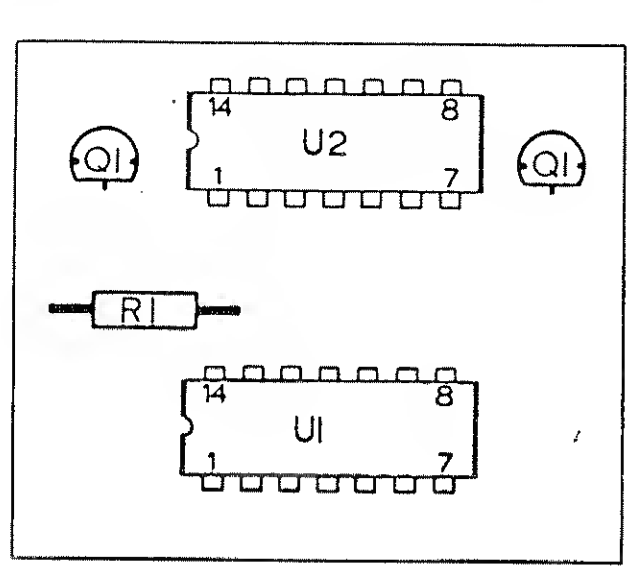
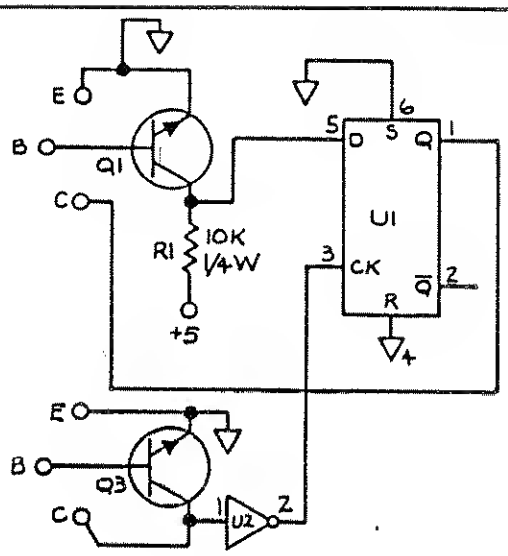


Figure 1. A4A1 O.U. Adapter Assy

On page 8-1,
ADD: 8-4a. A4A1 O.U. Adapter PCB Assy, 2180A-1021

On page 8-12, add Figure 2.





2180A–1621

IC	+5	GND
U1	14	7,8,9,10,11
U2	14	3,5,7,9,11,13

NOTES: Unless otherwise specified.
1. All resistance in ohms.
2. All capacitance in microfarads.
3. All resistors are 1/4W, 5%.

2180A–1021

Figure 2. A4A1 O.U. Adapter Assy

CHANGE #4 - 12993

AN UPDATED MICROCOMPUTER (TYPE #2) MAY BE PRESENT IN YOUR INSTRUMENT. IF SO, YOUR INSTRUMENT AT TURN ON WILL DISPLAY: "8002.2" AND YOU SHOULD PROCEED WITH THIS CHANGE. HOWEVER, IF YOUR INSTRUMENT AT TURN ON DISPLAYS "2180A.1" THEN YOU HAVE MICROCOMPUTER TYPE #1 AND THIS CHANGE SHOULD BE IGNORED.

On page iii/iv,

CHANGE: 1-3 General Specifications 1-3
TO: 1-4 General Specifications 1-4

ADD: 1-3 IPTS 68 Coefficients* 1-3
* For 2180A Curve Fit Linearizations

On page 1-1, replace paragraph 1-11 with,

1-11. Specifications for the 2180A Digital Thermometer are given in Table 1-4. These specifications assume that microcomputer type #2 has been installed in your instrument and at turn on the display reads "8002.2".

On page 1-2 and 1-3, replace Table 1-2 with Table 2.

Table 2. Total Instrument Accuracy Specifications (MICROCOMPUTER TYPE #2)

RTD TYPE	RESOLUTION IN	TEMPERATURE RANGE APPLICABLE PORTION OF °C	TEMPERATURE RANGE APPLICABLE PORTION OF °F	MAXIMUM ERROR* ±DEGREES C AT CAL	±DEGREES C 90 DAYS 20° to 30°	±DEGREES C 1 YR. 15° to 35°	±DEGREES F AT CAL	±DEGREES F 90 DAYS 68° to 86°	±DEGREES F 1 YR. 59° to 95°
100 ohm	.01°	-190 to 0	-309.9 to 32	.043	.089	.112	.076	.161	.203
		0 to 204	32 to 399.2	.043	.132	.173	.076	.239	.314
385 Pt	.1°	-190 to 0	-309.9 to 32	.11	.12	.14	.18	.21	.24
		0 to 750	32 to 1382.0	.11	.26	.37	.18	.46	.62
100 ohm	.01°	-200 to 0	-327.9 to 32	.009	.055	.078	.015	.100	.142
		0 to 204	32 to 399.2	.009	.098	.139	.015	.177	.252
390 Pt	.1°	-200 to 0	-327.9 to 32	.08	.10	.11	.13	.16	.19
		0 to 750	32 to 1382.2	.08	.23	.32	.13	.41	.57
100 ohm	.01°	-200 to 0	-327.9 to 32	.040	.086	.109	.071	.156	.198
		0 to 204	32 to 399.2	.040	.13	.171	.071	.234	.309
3916 Pt	.1°	-200 to 0	-327.9 to 32	.11	.12	.14	.17	.21	.24
		0 to 750	32 to 1382.2	.10	.26	.34	.17	.46	.62
100 ohm	.01°	-200 to 0	-327.9 to 32	.008	.055	.078	.014	.099	.141
		0 to 204	32 to 399.2	.009	.098	.139	.014	.177	.252
392 Pt	.1°	-200 to 0	-327.9 to 32	.08	.10	.11	.12	.16	.19
		0 to 750	32 to 1382.2	.08	.23	.32	.12	.41	.57
100 ohm	.01°	-60 to 0	-76 to 32	.129	.157	.172	.230	.282	.308
		0 to 93	32 to 199.4	.129	.176	.199	.231	.317	.359
617 Ni	.1°	-60 to 0	-76 to 32	.19	.20	.21	.33	.35	.36
		0 to 177	32 to 350.6	.19	.22	.25	.33	.39	.44
10 ohm	.01°	N/A							
CU	.1°	-75 to 0	-103 to 32	.16	.18	.19	.27	.31	.34
		-75 to 150	-103 to 302	.16	.20	.23	.27	.35	.41
OHMS		0 to 196.99	.005	.042	.059	ALL UNITS IN OHMS			
		0 to 999.99	.05	.22	.31				

* Maximum error depends on the temperaturo measured and the rosolution used. Of the four temperature ranges presented for eaoh RTD, the first two represent .01° resolution. The above maximum error numbers represent instrument errors only, and do not include the RTD probe.

On page 1-3,
CHANGE: Table 1-3. General Specifications
TO: Table 1-4. General Specifications

Add Table 1-3, as shown in Table 3.

Table 3.

Table 1-3. IPTS 68 Coefficients* (For Microcomputer Type #2 Curve Fit Linearization)	
RTD TYPE	RTD LINEARIZATION COEFFICIENTS
100 OHM 385 Pt	DIN 43760 TABLE
100 OHM 390 Pt	ALPHA = 0.0038994 DELTA = 1.494 A4 = -0.265668 X 10-4 C4 = -0.205984 X 10-11
100 OHM 3916 Pt	ALPHA = 0.003916 DELTA = 1.505 A4 = -.099668 X 10-5 C4 = -0.192912 X 10-13
100 OHM NI	ALPHA = 0.00617
10 OHM CU	R0 = 9.042 OHM R25 = 10.005 OHM ALPHA = .004260
* SEE NBS MONOGRAPH 126	

On page 1-4, replace the "RTD TYPES" specification with the following:

RTD TYPES
100 ohm 385 Pt (DIN),
100 ohm 390 Pt, 100 ohm 3916 Pt, 100 ohm 392 Pt,
100 ohm Ni (DIN), 10 ohm CU.

On page 2-4, paragraph 2-23:
Replace step 4 with,

4. On the Input Module toggle the RTD Seleotor Switch (S1) to obtain the desired RTD type, see Table 2-2.

NOTE

Your RTD Input Module may be printed with microeomputer Type #1 selector switch settings. Therefore we advise that you refer to Table 2-2 when changing RTD types.

Replace step 9 and the note following, with,

NOTE

R2 on the 2180A is adjusted at the factory with a 100 ohm input resistance. If the 2180A is used with a 100 ohm 385 Pt RTD probe meeting DIN standard #43760 then the R2 adjustment in the following paragraph may be skipped.

9. Adjust R2 on the RTD Input Module to compensate for variations in lead resistance and in RTD probe Ro values. Refer to section 4 for RTD input module adjustment procedures. This adjustment must be performed when an RTD probe is initially installed and whenever the leads or the RTD are changed.

NOTE

The R2 adjustment can be used to calibrate the 2180A and the probe near a specific temperature. Adjust R2 for agreement between the 2180A and a custormer supplied temperature reference at the temperatures of interest.

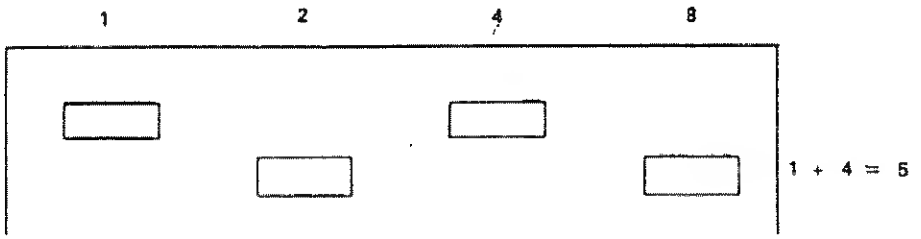
On page 2-5, replace Table 2-2 with Table 4.

Table 4. RTD Input Module Switch (S1) Settings

TYPE uP	DISPLAY READING AT TURN ON	RTD SELECTOR SWITCH (S1) SETTINGS									
		0	1	2	3	4	5	6	7	8	9
2	8002.2	100* 385**	100* 390**	100* 3916**	100* 392**	100* NI	10* CU	-	-	OHM	CAL

* = OHMS
** = PLATINUM (PT)

EXAMPLE: To select a switch setting of 5, position the RTD selector switch (S1) as shown:



In Table 2-3, for SWITCH NO. S3,
CHANGE: SCAN For future use only.
TO: SCAN Not used.

On page 4-3, paragraph 4-21, change the last sentence,
FROM: ... 25 +/-2 C (77.0 +/-3.6 F).
TO: ... 25 +/-5 C (73.4 +/-9 F).

On page 4-4, replace Table 4-3 with Table 5.

Table 5. 2180A Performance Test

MICROCOMPUTER #2							
OHM INPUT	SELECT SWITCH	READING °F	READING °C	90 DAY °F	90 DAY °C	1 YEAR °F	1 YEAR °C
	(0)						
39.650	100 ohm	-238.00	-150.00	.100	.054	.104	.057
212.030	385 Pt	572.0	300.0	.30	.17	.32	.19
345.210		1292.0	700.0	.44	.25	.49	.27
	(1)						
38.777	100 ohm	-238.00	-150.00	.044	.024	.049	.027
213.472	390 Pt	572.0	300.0	.25	.14	.28	.16
348.446		1292.0	700.0	.39	.22	.44	.25
	(2)						
38.679	100 ohm	-238.00	-150.00	.100	.055	.105	.058
213.929	3916 Pt	572.0	300.0	.28	.16	.30	.17
349.323		1292.0	700.0	.42	.24	.47	.26
	(3)						
38.612	100 ohm	-238.00	-150.00	.044	.024	.049	.027
214.135	392 Pt	572.0	300.0	.25	.14	.28	.16
349.909		1292.0	700.0	.39	.21	.43	.25
	(4)						
71.80	100 ohm	-67	-55.00	.26	.15	.27	.15
161.70	NI	212	100.0	.37	.21	.38	.22
219.00		347	175.0	.39	.22	.40	.23
	(5)						
6.201	10 ohm	-100	-73.3	.33	.19	.34	.19
14.778	CU	300	148.9	.35	.20	.37	.21

On page 4-6:
Change all references of "lag bath", to "ice bath".

Replace paragraph 4-38 and the five steps following, with,
4-38. The following instructions provide a recommended method of constructing an ice bath.

NOTE

Distilled water must be used to make the ice and must also be used in the ice bath.

1. Required material; supply of ice, distilled water and an insulated jar with an unbreakable lid (thermos or equivalent).

2. Prepare the insulated jar by drilling one or more holes just large enough to accept the RTD Probe or Probes.

3. Fill the insulated jar with shaved or crushed ice.

4. Fill the insulated jar with enough distilled water so that the ice becomes slush but not enough to float the ice.

NOTE

As the ice melts, siphon off the excess water and add more ice. Allow about 5 to 10 minutes for the water to drop back to the freezing point.

On page 5-3, Table 5-1,
CHANGE: U9|IC, MICROPROCESSOR|455014|01295|TMS9901N|1
TO: U9|IC, MICROPROCESSOR|525659|04713|MC3870CP|1

On page 600-1, Table 600-1,
DELETE: Y2025 | Probe, RTD, 100 ohm, 385 Pt

ERRATA #2

On page 4-5, paragraph 4-32:
Step 3, delete the second "the" in the sentence.

Step 5, replace the first sentence, with,
5. Set the calibrator output to 0.00102V and divider to +100 (10.2 uV to 2180A).

On page 4-6, paragraph 4-34:
Replace steps 6 through 9, with the following:
6. Change the calibrator output to 4.5V (45 mV to 2180A). The 2180A should read 45000 +/-2.

7. Set switch S2 out of AUTO. Set DC calibrator output to 9.9V and the divider to 10 (990 mV to 2180A).

8. Adjust R28 (.1 C cal potentiometer) for a reading of 99000 +/-1.

9. Change the calibrator output to 4.5V, the 2180A should read 45000 +/-2 (450 mV to 2180A).

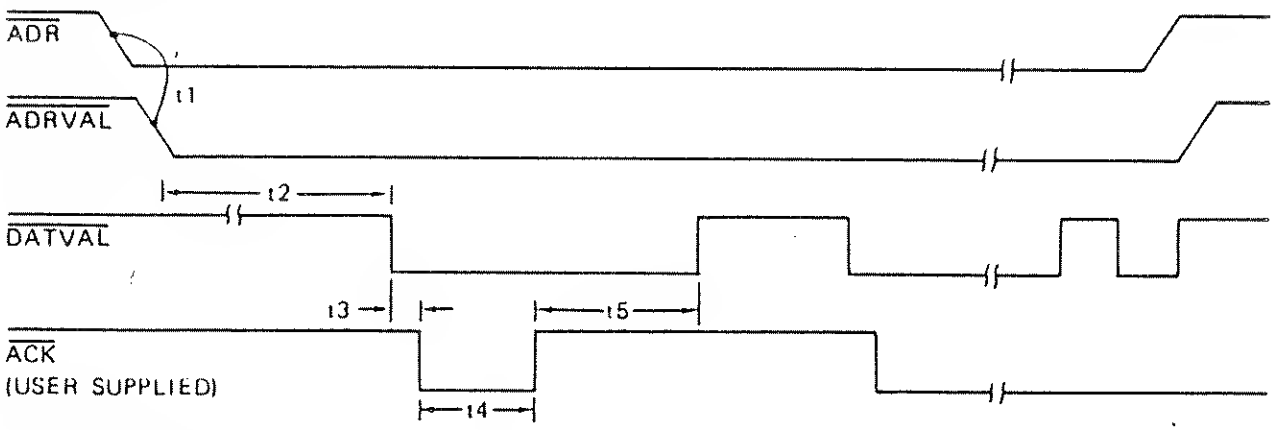
10. Place S2 in the AUTO position

On page 8-13, Figure 8-4, in the table on the far right, change U22 pin 4,
FROM: GND
TO: GND ISOLATED

ERRATA #3

On page 602-3, paragraph 602-25, change the last sentence,
FROM: The message formats are shown in Figure 602-1.
TO: The message formats are shown in Figure 602-1, and a timing diagram is given in Figure 602-1a.

On page 602-4, add Figure 602-1a as shown in Figure 3.



t1 1 uS max.
t2 20 uS tp 300 mS, depending upon reading cycle.
t3 0 uS min.
t4 20 uS min.
t5 20 uS typical

Figure 602-1a. Timing Diagram

Figure 3.

CHANGE #5 - 13540
Rev.-G, A4 Output Option -002 PCB Assembly (2180A-4020T)

On page 602-9, Table 602-5:

CHANGE:	U2	OPTO-ISOLATOR	380014	01295	T1L116	3
TO:	U2	XSTR PHOTO (OPTO-ISOLATOR)	536045	14936	MCT-26	3
CHANGE:	U3	OPTO-ISOLATOR	380014	01295	T1L116	REF
TO:	U3	XSTR PHOTO (OPTO-ISOLATOR)	536045	14936	MCT-26	REF
CHANGE:	U4	OPTO-ISOLATOR	380014	01295	T1L116	REF
TO:	U4	XSTR PHOTO (OPTO-ISOLATOR)	536045	14936	MCT-26	REF

ERRATA #4

On page 602-1, Table 602-1, add the following to the end of the Parallel ASCII Interface specification:

CMOS compatible, will drive one TTL load.

On page 602-4, paragraph 602-28, step 10,
CHANGE: ... R26 ...
TO: ... R15 ...

ERRATA #5

On page 602-2, paragraph 602-8, add the following to the end of step 6:

When using the RS-232-C interface, set the address switch S3 to address 1, 6, 7, 8 or 9. When using with the 2XXXA-522 Personality Card and the 1120A IEEE-488 Translator, set the baud rate to 2400 and follow all discussions regarding the RS-232-C interface.

On page 602-4, replace Figure 602-1, with Figure 4.

```
 1| 2| 3| 4| 5| 6| 7| 8| 9| 10| 11|12|13 |14 | 15|16|17|18|19|20|21
NORMAL TEMPERATURE MEASUREMENT DATA
CH|CH|SP|SP|± |SP|0 |0 |0 |0/.|0/.|D |SP |SP |F/C|SP|SP|SP|SP|CR|LF
OPEN THERMOCOUPLE OUTPUT (2190A only)
CH|CH|SP|SP|± |SP|0 |0 |0 |0/.|0/.|D |SP |SP |F/C|SP|SP|0 |C |CR|LF
OVERRANGE OUTPOT
CH|CH|SP|SP|± |SP|0 |0 |0 |0/.|0/.|D |SP |SP |F/C|SP|SP|0 |L |CR|LF
```

NOTE: If the limits option in the thermometer is installed (option 21X0A-006) and is indioating an out of limit oondition, charaoter slot 17 will be an exclamation point (!) for any of the three above modes.

SYMBOL	OESCRIPTION
CH	Channel indent numbers (00 thru 99)
SP	Space
!	Thermometer limits Option Setpoint exoeeded symbol
±	Plus or minus symbol
0	Temperature data values (0 thru 9)
.	Floating decimal point, will be in oharacter slots 11 or 12 or slot 12 when used with 2180A or 2190A Thermometer resp.
F/C	Fahrenheit or Celsius
CR	Carriage Return
LF	Line Feed
?	Question mark
OT	Open Thermoooouple (Character slots 16 and 17)
OR	Over Range (Character slots 16 and 17)

Figure 4. Measurement Data Output Format for RS-232-C and Current Loop Ports

CHANGE #6 - 15520
Rev.-D, A1 Main PCB Assembly (Thermometer PCB Assy)

On pages 5-6 through 5-8, Table 5-2:

CHANGE: C26|CAP, ELECT, 4000 UF -10/+100%, 25V
|370734|80031|3044TS043U025|1|1

TO: C26|CAP, ELECT, 4700 UF -10/+30%, 25V
|615567|89536|615537 |1|1

Change the FLUKE STOCK NO. and the MFG PART NO. for R1,
FROM: 474338
TO: 603258

CHANGE: R33|RES, COMP, 330 +/-5%, 1/4W|147967|01121|CB3315 |2
TO: R33|RES,DEP.CAR,330 +/-5%,1/4W|368720|80031|CR251-4-5P330E|2

CHANGE: R53|RES, COMP, 330 +/-5%, 1/4W|147967|01121|CB3315 |REF
TO: R53|RES,DEP.CAR,330 +/-5%,1/4W|368720|80031|CR251-4-5P330E|REF

ADD: R55|RES, VAR, CER, 25K +/-20%, 1/2W|285213|11236|190PC253B|1

On page 5-10, Figure 5-2, add R55 as shown in Figure 5.

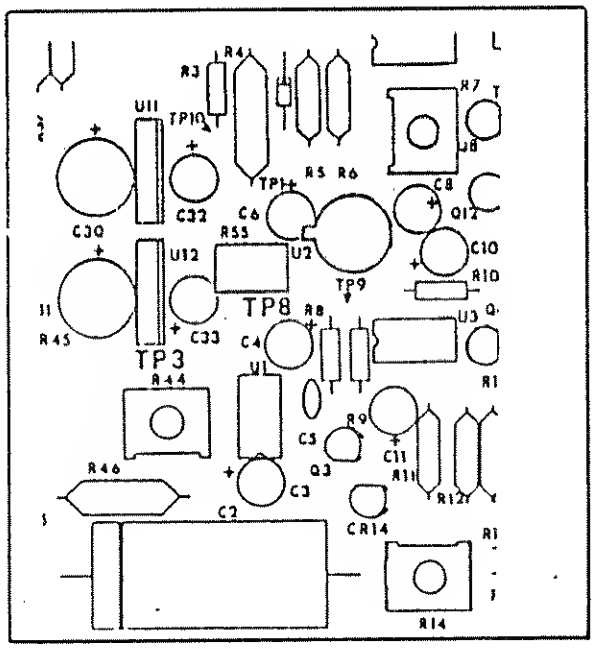


Figure 5.

On pages 8-3 and 8-5, Figure 8-1, add R55 as shown in Figure 6, and change the value of C26,

FROM: 4000
TO: 4700 uF

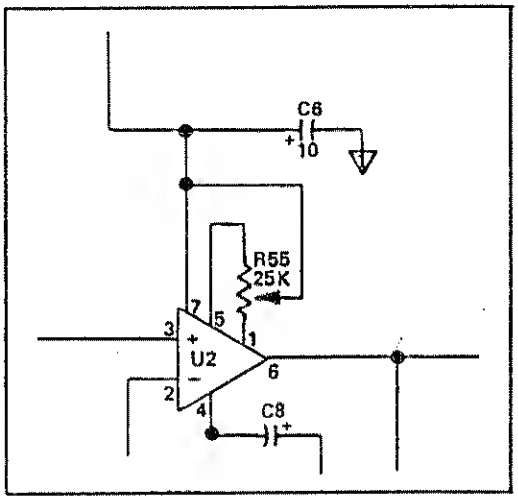


Figure 6.

CHANGE #7 - 15725
Rev.-E, A1 Main PCB Assembly (Thermometer PCB Assembly) (2180A-4001T)

On pages 5-6 and 5-7, Table 5-2,

CHANGE: C26|CAP, ELECT, 4700 UF -10/+30%, 25V
|615567|89536|615537|1|1

TO: C26|CAP, ELECT, 4700 UF -10/+30, 25V
|614115|89536|614115|1|1

ADD: MP4|CLAMP, CABLE W/C26|172080|89536|172080|1

CHANGE #8 - 16011
Rev.-H, A4 Output Option PCB Assembly (2180A-4020T)

On pages 602-8 and 602-9, Table 602-5:

CHANGE: U14|TRANSISTOR, J-FET, N-CHANNEL|460014|89536|460014|1|1
TO: U14|XSTR, FET, DUAL N-CHAN |419283|89536|419283|1|1

On page 602-10, Figure 602-2, change the configuration of U14 as shown in Figure 7.

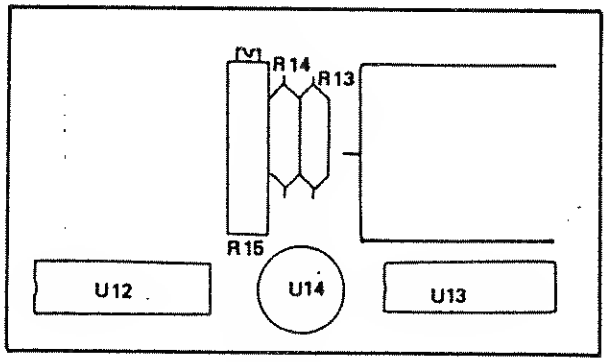


Figure 7.

On page 8-11, Figure 8-4, change the pin assignments as shown in Figure 8.

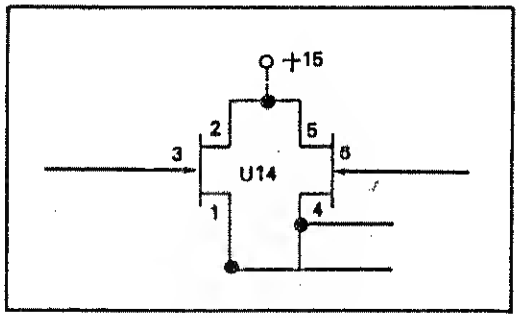


Figure 8.

ERRATA #6

On page 602-9, Table 602-5, change the MFG PART NO. for U10,
FROM: MC1406BCP
TO: MC14069UBCP

ERRATA #7

On page 4-5, paragraph 4-32, add the following to the end of step 3.

Toggle S3 to manual position.

ERRATA #8

On page 4-3, paragraph 4-22, step 6:
CHANGE: ... 5 minutes).
TO: ...20 minutes).

On page 4-5, paragraph 4-26, step 2:
CHANGE: ... 5 minutes).
TO: ...20 minutes).

ERRATA #9

On page 5-7, Table 5-2:
CHANGE: H5|WASHER, FLAT |147728|73734|1402 |2
TO: H5|WASHER, FLAT #4|110775|89536|110775|2

ERRATA #10

On page 5-3, Table 5-1, change the FLUKE STOCK NO. and MFG PART NO. for MP9,
FROM: 472282
TO: 655522

CHANGE #9 - 16985
Rev.-G, A1 Main PCB Assembly (2180A-4001)

On page 5-9, Table 5-2, change the FLUKE STOCK NO. and MFG PART NO. for U6,
FROM: 448480
TO: 510628

CHANGE #10 - 17669
Rev.-D, A3 RTD Input PCB Assembly (2180A-4003)

On page 5-12, Figure 5-4 and page 8-9, Figure 8-3, remove the type select table from the middle of the board.

CHANGE #11 - 18905
Rev.-H, A1 Main PCB Assembly (2180A-4001)

On page 5-7, Figure 5-2:
CHANGE: MP4|CLAMP, CABLE W/C26|172080|89536|172080|1
TO: MP4|CLAMP, CABLE W/C26|530360|89536|530360|1

CHANGE #12 - 19720
Rev.-K, A1 Main PCB Assembly (2180A-4001)

On page 5-9, Table 5-2:
CHANGE: U6 |...
TO: U6A|...

ADD: U6B|RES, NETWORK|577536|89536|577536|1|1

On page 8-3, Figure 8-1, indicate three U6A's and three U6B's as shown in Figure 9.

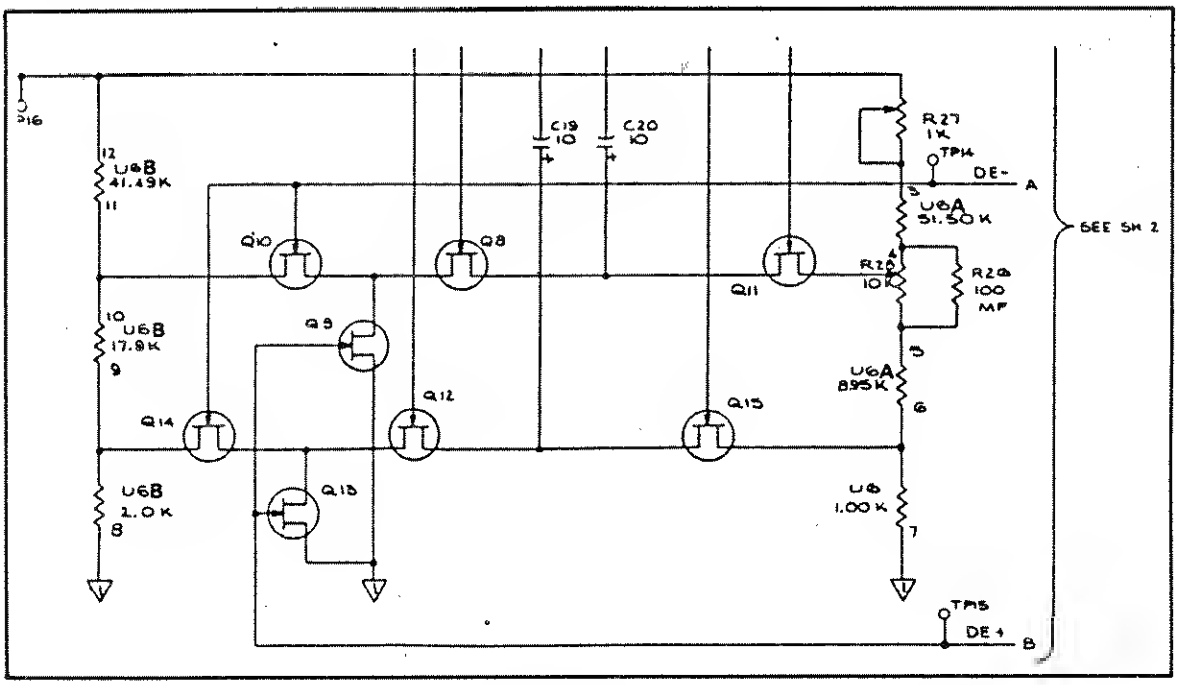


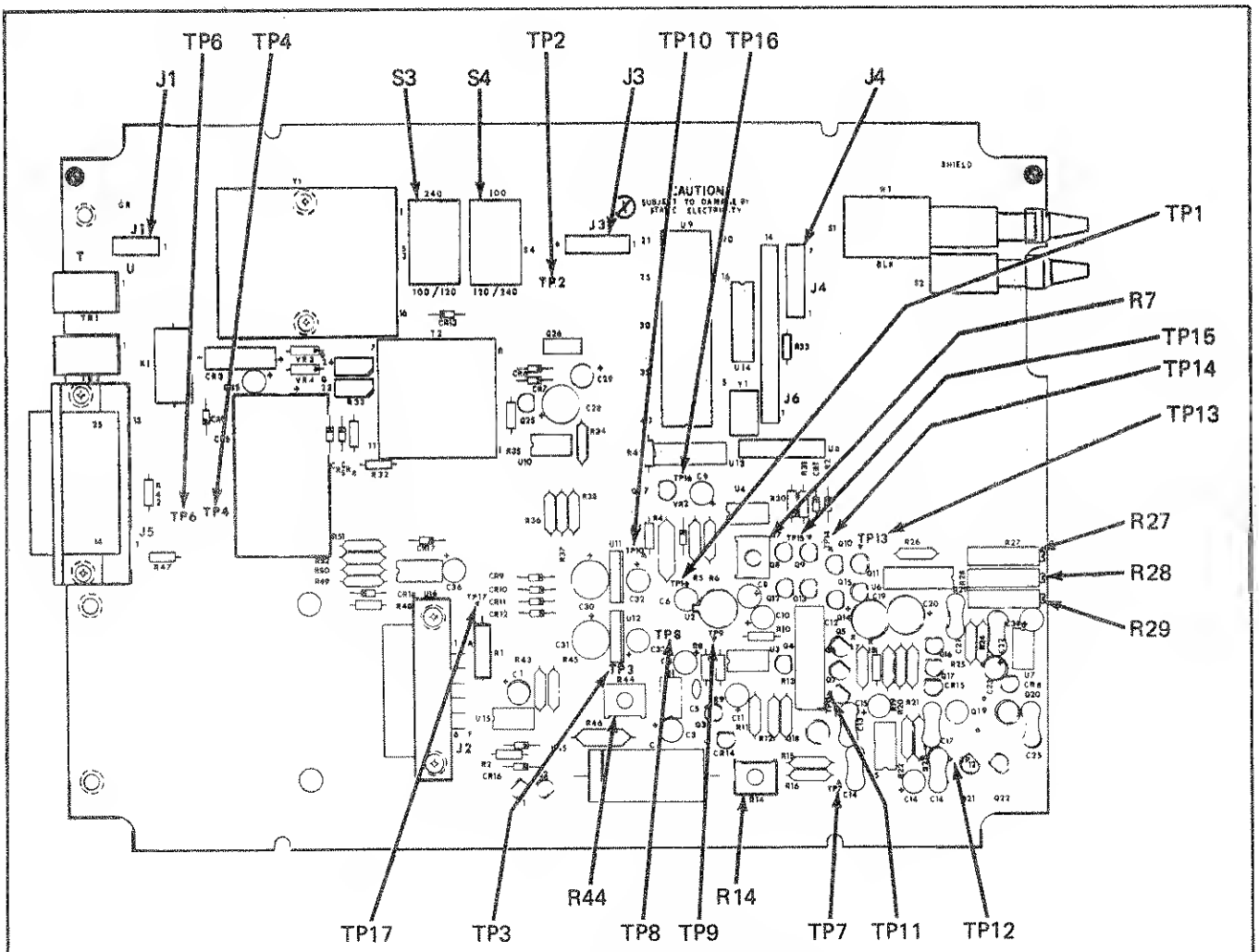
Figure 9.

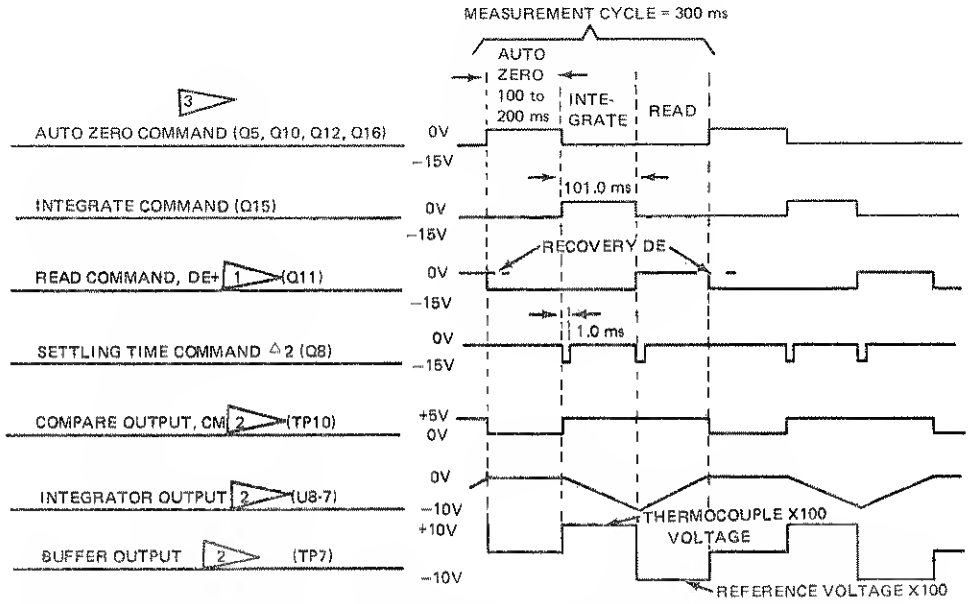
Table 4-4. 2180A Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Input 0 volts from the divider to +S (HI); –S, –V (LO); leave +V disconnected.		
2	Set the RTD selector switch to setting 9 (Cal).		
3	Apply power to the thermometer.		
4	Does the displey read 2180.X for ten seconds and then change to 0°C (0°F)?	14	5
	NOTE *X = a numeral depending on the version of software installed.*		
5	Does any portion of the display illuminate?	13	6
6	Measure between TP2 (REF) and TP4 for +5 ±10% VDC, between TP1 (REF) and TP3 for +15 ±5% VDC.		
7	Are all voltages correct?	12	8
8	Measure between pin 8 of T2 and the negative end of C26 for a DC voltage greater than 10.3V and for a peak-to-peak wave form between pins 8 and 9 of T2 approximately twice the value of the DC voltage measured at pin 8.		
9	Are both signals present and correct?	11	10
10	Check the inverter circuit that drives the transformer (T2). Repair as required then resume at step 3.		
11	Check the transformer secondaries and if any are bad, check the individual regulators and their associeted components. NOTE: Analog circuitry may load down the ±15V supplies. Repair as required then resume at step 3.		
12	Check the +5V path to the Display PC8 and the Display PC8 Connector. Repair as required then resume at step 3.		
13	Check the strobes (U9-3, 4, 5, 6, 19) and display seven segment control lines (U9-8, 9, 10, 11, 12, 13, 14). Repair as required then resume at step.3.		
14	Set the RTD selector switch to the setting of the type RTD to be connected in the next step.		
15	Connect an RTD to the thermometer and measure some known temperature. (A lag bath is suggested.)		
16	Is the displeyed tempereture correct?	37	17
17	Check the RTD components end the ground sense buffer emp (U7, Q20 end their essocieted components). Repeir es required then resume et step 14.		
18	Can the Callbration Adjustment Procedure be performed?	37	19
19	Are control signals at U9 pins 26, 27, 30, 31, 32 toggling between high and low logic levels? NOTE: the X100 signal at pin 33 of U9 will remain low (0V) unless unit is in 0.1° Range. (Use TP2 as common.)	21	20
20	Replace the microcomputer U9, then resume at step 14.		
21	Are the outputs of U13 toggling between high and low logic levels? NOTE: The output at pin 1 of U13 will remain low (0V) unless 2180 is in 0.1° Range.	23	22

Table 4-4. 2180A Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
22	Check U13, Q27 and their associated components. Repair as required then resume at step 14.		
23	Is the wavaform at TP7 as shown in Figure 4-4 (Megnitude & Polarity varies with the input signal)?	30	29
24	Is there 6.2 Vdc at TP16? (Use TP1 as common.)	26	25
25	Check the Reference Circuit providing an input at U4-3 from the divider R4, R5, R6, R7 and VR2. Repair as required then resume at step 14.		
26	Check from TP1 (analog ground) to U6-6 for 100 mV dc and for approximately 200 mV dc at U6-9.		
27	Are both voltages present?	29	28
28	Check Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15 and their associated components. Repair as required then resume at step 14.		
29	Check the RTD Input Module plus U5-1, Q19, Q21, Q22, and their associated components. Repair as required then resume at step 14.		
30	Is the waveform at U5-7 as shown in Figure 4-4 (Magnitude & Polarity varies with the input signal)?	34	31
31	Check the operation of Q5, Q6, Q7, Q18, U5 and their associated components. If any defective components are found, repair as required and resume at step 13. If none are found proceed to the next step.		
32	Connect TP2 and TP6 with a jumper to lock the instrument in the Auto Zero period.		
33	Check U5, U3, U2, Q4 and their associated components. This circuit should now function as a closed loop amplifier. Repair as required. Remove the jumper between TP2 and TP6 and resume at step 14.		
34	Does TP10 toggle between the high and low logic levels?	36	35
35	Check U1 and its associated components then resume at step 14.		
36	Replace the microcomputer U9, then resume at step 14.		
37	Troubleshooting of the 2180A is complete. Remove all test equipment, reconnect any cables removed and close the instrument.		





1 DE+ is generated for positive input voltages. Negative input voltages enable the DE− mode which, in turn, operates FET switch, Q13.

2 Waveform is shown for positive input voltage. It is inverted for negative inputs. Shown for full-scale in.

3 The Q numbers in parenthesis represent FET switches operated by the commands. See Figure 3-3.

Figure 4-4. Test Points and Measurement Cycle Waveforms

Table 4-5. Test Point Identification

TP1	Analog Common
TP2	Digital Common (—15V) (refer to Analog Common)
TP3	+15V (refer to Analog Common)
TP4	+5V (refer to Analog Common)
TP6	(U9-17) Trigger — S
TP7	Buffer Amp out (U5-1)
TP8	(U2-6)
TP9	Gain Stage out (U3-6)
TP10	Comparator out (U1-7) CM
TP11	△ 2 Settling Time Command
TP12	INT 1 Integrate Command
TP13	AZ Auto Zero Command
TP14	DE— Read Command (Negative Input)
TP15	DE+ Read Command (Positive Input)
TP16	6.2V (±100 uV)
TP17	6.2V (±100 uV)

Section 5
List of Replaceable Parts

TABLE OF CONTENTS

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. A similar parts listing for each of the options will be found in Section 6. Components are listed alphanumerically by assembly. Both electrical and mecbanical components are listed by reference designation. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation.

2. Description of each part.

3. FLUKE Stock Number.

4. Federal Supply Code for Manufacturers. (See Section 7 for Code-to-Name list.)

5. Manufacturer's Part Number.

6. Total Quantity per assembly or component.

7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity.

2. FLUKE Stock Number.

3. Description.

4. Reference Designation.

5. Printed Circuit Board Part Number.

6. Instrument Model and Serial Number.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 5-1. Final Assembly, 2180A Digital Thermometer

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FINAL ASSY, 2180A DIGITAL THERMOMETER						
	FIGURE 5-1						
A1	Ø MAIN PCB ASSEMBLY	469312	89536	469312	1		
A2	DISPLAY PCB ASSEMBLY	464297	89536	464297	1		
A3	RTD INPUT PCB ASSEMBLY	464305	89536	464305	1		
F1	FUSE, U.S.				1	5	
	FOR 100/120V OPERATION						
	SLO-BLO, 1/16 AMP	163030	71400	MDL1-16			
	FOR 240V OPERATION						
	SLO-BLO, 1/8 AMP	166488	71400	MDL1-8			
F1	FUSE, METRIC, 5 X 20 MM				1	5	
	FOR 100/120V OPERATION						
	SLO-BLO, 1/16 AMP	467381	89536	467381			
	FOR 200/240V OPERATION						
	SLO-BLO, 1/8 AMP	467233	89536	467233			
F2	FUSE, SLO-BLO, 3/4 AMP	109256	71400	MDL3-4	1	5	
H1	SCREW, PHP, 6-20 X 3/8	288266	89536	288266	1		
H2	SCREW, PHP, 4-40 X 1/4	256156	89536	256156	3		
H3	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	2		
H4	SCREW, FHP, 4-40 X 3/8	256024	89536	256024	1		
H5	SCREW, FHP, 6-32 X 5/8	335158	89536	335158	2		
H6	SCREW, FHP, 6-32 X 5/8	114876	89536	114876			
MP1	BASE, STD	454702	89536	454702	1		
MP2	GUARD, BASE	464404	89536	464404	1		
MP3	REAR PANEL	464149	89536	464149	1		
MP4	OUTPUT OPTION COVER	464412	89536	464412	1		
MP5	LIMITS COVER	464156	89536	464156	1		
MP6	LATCH	467548	89536	467548	2		
MP7	STAND, BAIL	467555	89536	467555	1		
MP8	FOOT, NON-SKID	467571	89536	467571	4		
MP9	FRONT PANEL	472282	89536	472282	1		
MP10	CALIBRATION COVER	471490	89536	471490	1		
MP11	DECAL, FRONT PANEL	454629	89536	454629	1		
MP12	DECAL, BASE SIDES	473652	89536	473652	2		
MP13	DECAL, REAR PANEL	454645	89536	454645	1		
MP14	DECAL, BOTTOM	473637	89536	473637	1		
MP15	CARD GUIDE	464164	89536	464164	2		
MP16	DECAL, RETAINER	473645	89536	473645	2		
MP17	HANDLE	454751	89536	454751	1		
MP18	RETAINER, HANDLE	467563	89536	467563	2		
MP19	GUARD, COVER, C-SIZE	464115	89536	464115	1		
MP20	COVER, C-SIZE	454736	89536	454736	1		
MP21	LUG, SOLDER	151431	79963	329	1		
U9	IC, MICROPROCESSOR	455014	01295	TMS9901N	1		
W1	CABLE ASSY	475228	89536	475228	1		
W2	POWER CORD (NOT SHOWN)	343723	89536	343723	1		
XF1	FUSEHOLDER, HIGH LEAD	375188	89536	375188	2		
XF1-1	FUSE CAP	460238	89536	460238	2		
	FUSE CAP, METRIC	461020	89536	461020	1		
	MANUAL, INSTRUCTION (NOT SHOWN)	489211	89536	489211	1		

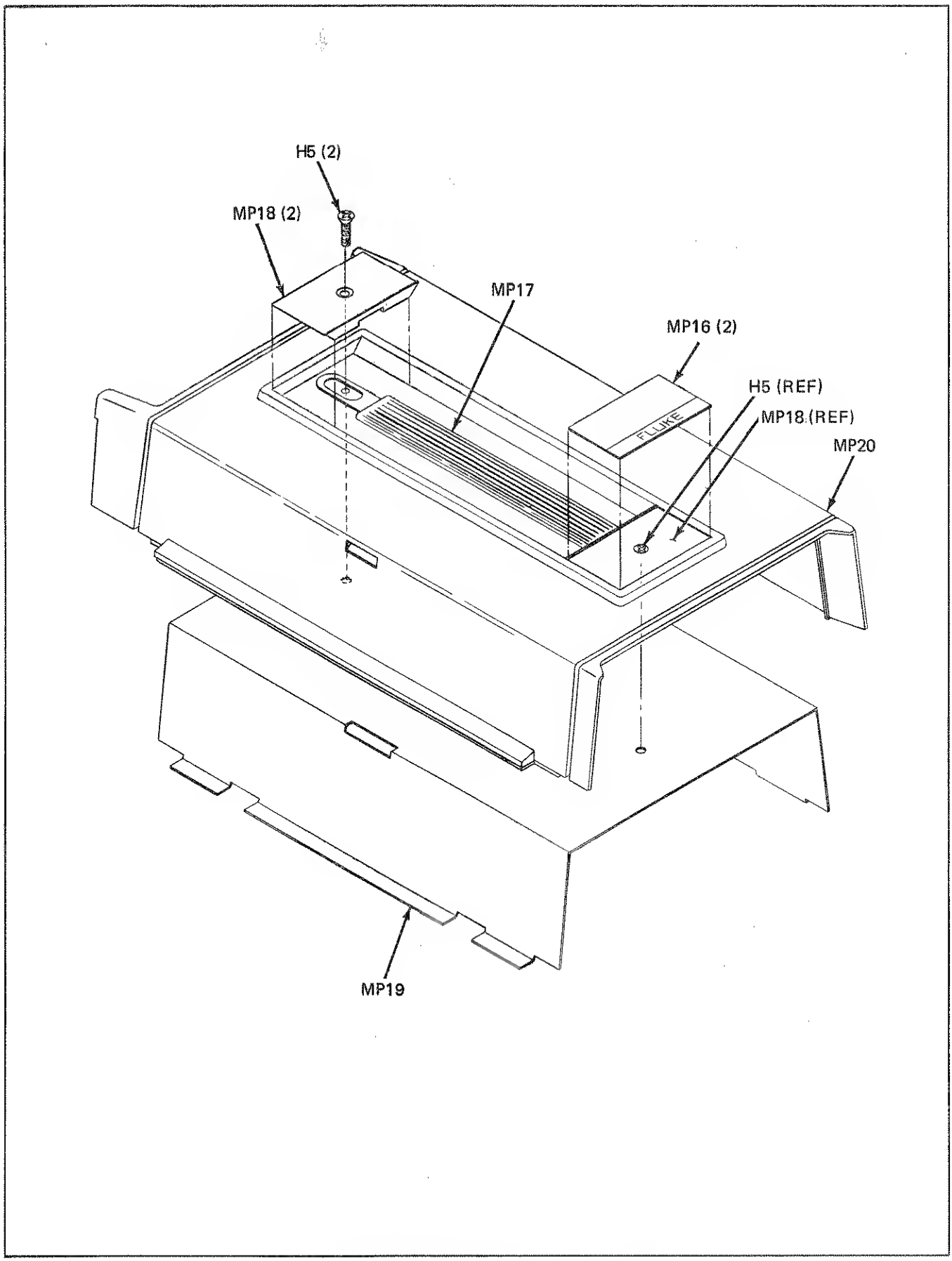


Figure 5-1. Final Assembly, 2180A Digital Thermometer

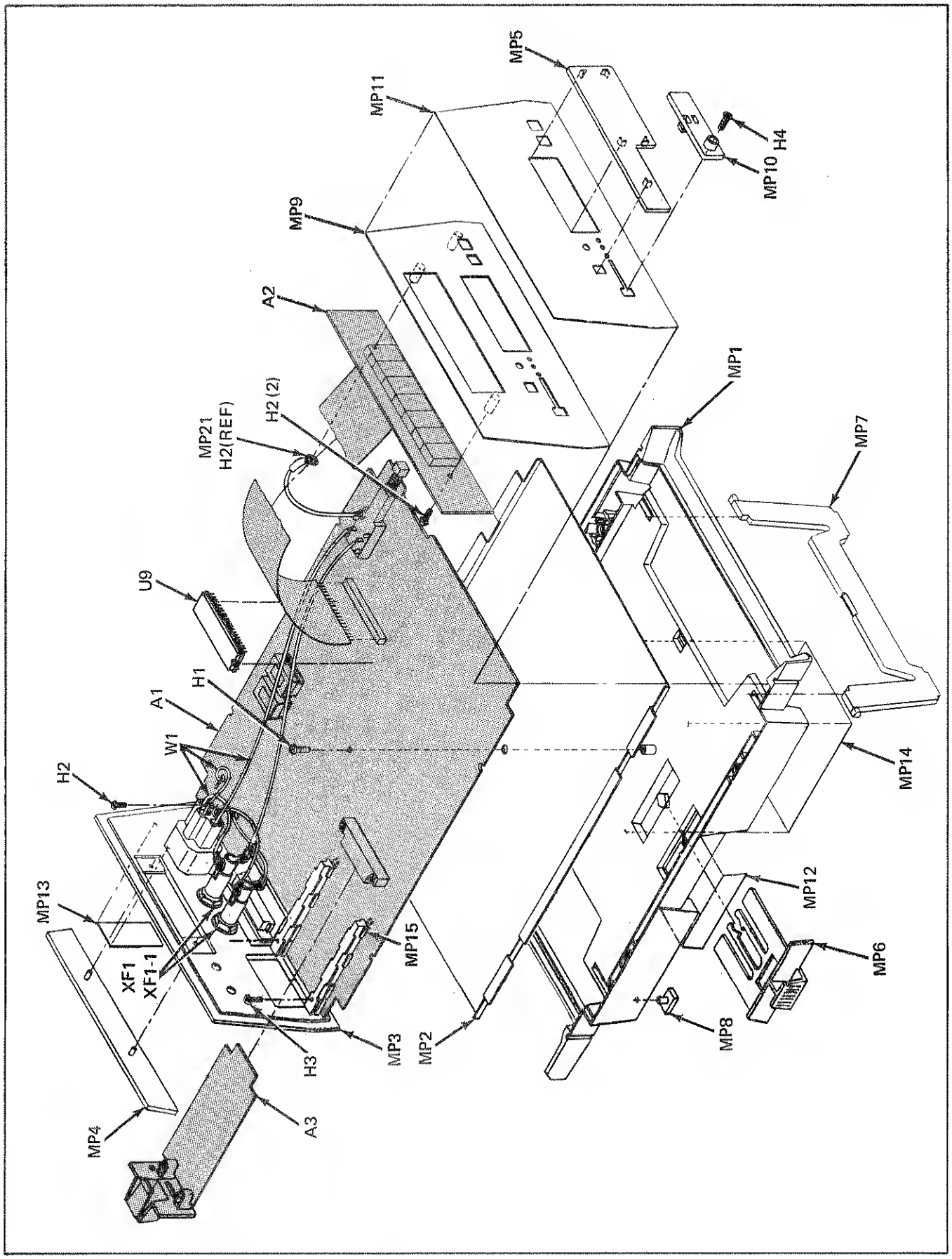


Figure 5-1. Final Assembly, 2180A Digital Thermometer (cont)

Table 5-2. A1 Main PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	Ⓐ MAIN PCB ASSEMBLY (THERMOMETER PCB ASSEMBLY) FIGURE 5-2 (2180A-4001T)	469312	89536	469312	REF		
C1	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	16		
C2	CAP, PLYPRLN, 0.47 UF +/-5%, 50V	364042	84411	JE78B	1		
C3	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C4	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C5	CAP, CER, 0.0012 UF +/-10%, 500V	106732	71590	CF122	1		
C6	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C8	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C9	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C10	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C11	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C12	CAP, POLYCARB, 2.2 UF +/-10%, 100V	306522	80031	C280MCH/A2M2	1		
C13	CAP, MICA 430 PF +/-5%, 500V	177980	72136	DM15F431J	6		
C14	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		
C15	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C16	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C17	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		
C18	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		
C19	CAP, TA, 10 UF +/-20%, 35V	417683	56289	196D106X0035PE4	2		
C20	CAP, TA, 10 UF +/-20%, 35V	417683	56289	196D106X0035PE4	REF		
C21	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		
C22	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		
C23	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C24	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C25	CAP, MICA, 5 PF +/-0.5%, 500V	148577	72136	DM15C050E	1		
C26	CAP, ELECT, 4000 UF -10/+100%, 25V	370734	80031	3044TS043U025	1	1	
C28	CAP, TA, 39 UF +/-20%, 20V	358234	56289	196D396X0020PE4	1		
C29	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C30	CAP, TA, 22 UF +/-20%, 35V	394775	56289	196D226X0035TE4	2		
C31	CAP, TA, 22 UF +/-20%, 35V	394775	56289	196D226X0035TE4	REF		
C32	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C33	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C35	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C36	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	1		
CR1	DIODE, SI, HI-SPEED SWITCH	203323	D7910	1N4448	10	2	
CR2	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR3	RECTIFIER BRIDGE, 2 AMP	392910	09423	FB200	1	1	
CR4	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR5	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR6	DIODE, SI, RECTIFIER	379412	04713	1N4933	2	1	
CR7	DIODE, SI, RECTIFIER	379412	04713	1N4933	REF		
CR8	DIODE, FET, CURRENT, REGULATOR	348482	89536	348482	3	1	
CR9	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR10	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR11	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR12	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR13	DIODE, SI, RECTIFIER	116111	05277	1N4817	1	1	
CR14	DIODE, FET, CURRENT, REGULATOR	348482	89536	348482	REF		
CR15	DIODE, FET, CURRENT, REGULATOR	348482	89536	348482	REF		

Table 5-2. A1 Main PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR16	DIODE, SI, MULTI-PELLET	375477	09214	MPD200	1	1	
CR17	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR18	DIODE, ZENER	393579	04713	1N4567	1	1	
CR19	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
H1	SCREW, PHP, 4-40 X 1 1/2	156380	73734	19032	2		
H2	SCREW, PHP, 4-40 X 1/2	152132	73734	19026	2		
H3	SCREW, PHP, 4-40 X 3/8	152124	73734	19024	2		
H4	LOCKWASHER, SPLIT, #4	110395	89536	110395	2		
H5	WASHER, FLAT	147728	73734	1402	2		
J1	CONNECTOR, SOCKET, 4-POS.	461756	00779	583773-1	1		
J2	CONNECTOR, RECEPTACLE, 12-CONTACTS	474007	05574	2VH6/1AKC15	1		
J3	CONNECTOR, SOCKET, 6-POS.	448209	00779	1-583773-3	1		
J4	CONNECTOR, SOCKET, 7-POS.	484030	00779	1-583773-4	1		
J5	CONNECTOR, "D" SHELL, 25-CONTACTS	461996	00779	206584-1	1		
J6	CONNECTOR, SOCKET, 18-POS.	435024	00779	583773-8	1		
K1	RELAY, DRY REED	357582	71707	UF-40070	1		
MP1	BUTTON, GREEN (TO S1)	445197	89536	445197	1		
MP2	BUTTON, LT. PUTTY GREY (TO S2)	425900	89536	425900	1		
MP3	SPACER, DISO-PAD (NOT SHOWN)	296319	32559	TO-8-06	2		
Q1	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	9	2	
Q2	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q3	TRANSISTOR, SI, NPN	218396	04713	2N3904	3	1	
Q4	TRANSISTOR, FET, N-CHANNEL	376475	89536	376475	8	2	
Q5	TRANSISTOR, 4 VOLT OFF FET	429977	89536	429977	1	1	
Q6	TRANSISTOR, FET, N-CHANNEL	376475	89536	376475	REF		
Q7	TRANSISTOR, FET, N-CHANNEL	376475	89536	376475	REF		
Q8	TRANSISTOR, FET, N-CHANNEL	376475	89536	376475	REF		
Q9	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q10	TRANSISTOR, FET, N-CHANNEL	376475	89536	376475	REF		
Q11	TRANSISTOR, FET, N-CHANNEL	376475	89536	376475	REF		
Q12	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q13	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q14	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q15	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q16	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q17	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q18	TRANSISTOR, FET, DUAL N-CHANNEL	419283	89536	419283	1	1	
Q19	TRANSISTOR, DUAL, FET	476911	89536	476911	2	1	
Q20	TRANSISTOR, DUAL, FET	476911	89536	476911	REF		
Q21	TRANSISTOR, FET, N-CHANNEL	376475	89536	376475	REF		
Q22	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q23	TRANSISTOR, SI, NPN, PWR	477331	04713	MDS01A	2	1	
Q24	TRANSISTOR, SI, NPN, PWR	477331	04713	MDS01A	REF		
Q25	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q26	TRANSISTOR, SI, PNP, PWR	473207	01295	TIP30	1	1	
Q27	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
R1	RES, WW, 11.75K +/-0.5%	474338	89536	474338	1	1	
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R3	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
R4	ZENER REFERENCE SET (VR2, R4, R5)	377283	89536	377283	2	1	

Table 5-2. A1 Main PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R5	ZENER REFERENCE SET (VR2, R4, R5)	377283	89536	377283	REF		
R6	RES, MTL. FILM, 61.9K +/-1%, 1/8W	237230	91637	CMF556192F	2		
R7	RES, VAR, 500 +/-10%, 1/2W	325613	89536	325613	2	1	
R8	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3	2		
R9	RES, DEP. CAR, 43K +/-5%, 1/4W	442418	80031	CR251-4-5P43K	1		
R10	RES, DEP. CAR, 27K +/-5%, 1/4W	441501	80031	CR251-4-5P27K	1		
R11	RES, MTL. FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	6		
R12	RES, MTL. FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	REF		
R13	RES, MTL. FILM, 1K +/-1%, 1/8W	168229	91637	CMF551001F	1		
R14	RES, VAR, CER, 500K +/-10%, 1/2W	474387	11236	360T-503A	1	1	
R15	RES, MTL. FILM, 49.9 +/-1%, 1/8W	305896	91637	CMF554994F	1		
R16	RES, MTL. FILM, 169K +/-1%, 1/8W	289454	91637	CMF551693F	1		
R17	RES, MTL. FILM, 215K +/-1%, 1/8W	289470	91637	CMF552153F	1		
R18	RES, DEP. CAR, 12K +/-5%, 1/4W	348847	80031	CR251-4-5P12K	1		
R19	RES, MTL. FILM, 20K +/-1%, 1/8W	291872	91637	CMF552002F	1		
R20	RES, MTL. FILM, 2K +/-1%, 1/8W	235226	91637	CMF552210F	1		
R21	RES, MTL. FILM, 221 +/-1%, 1/8W	340794	91637	CMF552210F	1		
R22	RES, MTL. FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	REF		
R23	RES, MTL. FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	REF		
R24	RES, MTL. FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	REF		
R25	RES, MTL. FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	REF		
R26	RES, MTL. FILM, 100 +/-1%, 1/8W	357400	91637	CMF551000B	1		
R27	RES, VAR, 1K +/-20%, 1/2W	267856	73578	190PC102B	1	1	
R28	RES, VAR, 10K +/-20%, 1/2W	267880	75378	190PC1038	2		
R29	RES, VAR, 10K +/-20%, 1/2W	267880	75378	190PC1038	REF		
R30	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	2		
R31	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R32	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3	REF		
R33	RES, COMP, 330 +/-5%, 1/4W	147967	01121	CB3315	2		
R35	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	1		
R36	RES, MTL. FILM, 9.09K +/-1%, 1/8W	221663	91637	CMF559091F	1		
R37	RES, MTL. FILM, 1.02K +/-1%, 1/8W	223545	91637	CMF551021F	1		
R38	RES, MTL. FILM, 4.23K +/-1%, 1/8W	294819	91637	CMF554321F	1		
R39	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	CMF551002F	1		
R41	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	REF		
R42	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1T	1	1	
R43	ZENER REFERENCE SET (VR5, R43, R46)	377283	89536	377283	2	1	
R44	RES, VAR, 500 +/-10%, 1/2W	325613	89536	325613	REF		
R45	RES, MTL. FILM, 61.9K +/-1%, 1/8W	237230	91637	CMF556192F	REF		
R46	ZENER REFERENCE SET (VR5, R43, R46)	377283	89536	377283	REF		
R47	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R48	RES, DEP. CAR, 39K +/-5%, 1/4W	442400	80031	CR215-4-5P39K	1		
R49	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	1		
R50	RES, MTL. FILM, 64.9K +/-1%, 1/8W	288530	91637	CMF556492F	1		
R51	RES, MTL. FILM, 226K +/-1%, 1/8W	320879	91637	CMF552263F	1		
R52	RES, MTL. FILM, 309K +/-1%, 1/8W	235283	91637	CMF553093F	1		
R53	RES, COMP, 330 +/-5%, 1/4W	147967	01121	CB3315	REF		
S1/S2	SWITCH ASSEMBLY	483891	89536	483891	1		
S3	SWITCH, SLIDE, DPDT	234278	82389	XW1649	2		
S4	SWITCH, SLIDE, DPDT	234278	82389	XW1649	REF		

Table 5-2. A1 Main PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
T1	TRANSFORMER, PWR	464370	89536	464370	1		
T2	TRANSFORMER, INVERTER	461954	89536	461954	1		
TB1	TERMINAL BLOCK	479006	89536	479006	2		
TB2	TERMINAL BLOCK	479006	89536	479006	REF		
U1	IC, VOLTAGE COMPARATOR	352195	12040	LM311CN	1	1	
U2	IC, LINEAR, OP-AMP	429837	12040	LF356H	1	1	
U3	IC, LINEAR, OP-AMP	472779	12040	LF356N	2	1	
U4	IC, LINEAR, OP-AMP	413740	12040	LM307N	2	1	
U5	IC, LINEAR, DUAL OP-AMP	478032	04713	MC4558NCP1	1	1	
U6	RES NETWORK	448480	89536	448480	1	1	
U7	IC, LINEAR, OP-AMP	472779	12040	LF356N	REF		
U8	RES NETWORK, 47K	413289	89536	413289	1	1	
U10	IC, LINEAR, OP-AMP	418566	12040	LM358N	1	1	
U11	IC, LINEAR, NEG VOL REG	413179	12040	LM7915T	1	1	
U12	IC, LINEAR, VOL REG, FXD	413187	12040	LM340T-15	1	1	
U13	Ⓐ IC, C-MOS, HEX, OPEN DRAIN BUFFERS	473389	12040	MM74C906N	1	1	
U14	RES NETWORK	402644	89536	402644	1	1	
U15	IC, LINEAR, OP-AMP	413740	12040	LM307N	REF		
U16	IC, DUAL COMPARATOR	478354	12040	LM393N	1	1	
VR2	ZENER REFERENCE SET (VR2, R4, R5)	377283	89536	377283	REF		
VR3	DIODE, ZENER	186163	07910	1N974B	2		
VR4	DIODE, ZENER	186163	07910	1N974B	REF		
VR5	ZENER REFERENCE SET (VR5, R43, R46)	377283	89536	377283	REF		
XQ26	HEATSINK (NOT SHOWN)	428805	89536	428805	1		
XU4	SOCKET, IC, 40-PIN (NOT SHOWN)	418988	91506	340-AG39D	1		
Y1	CRYSTAL, QUARTZ	474072	89536	474072	1	1	

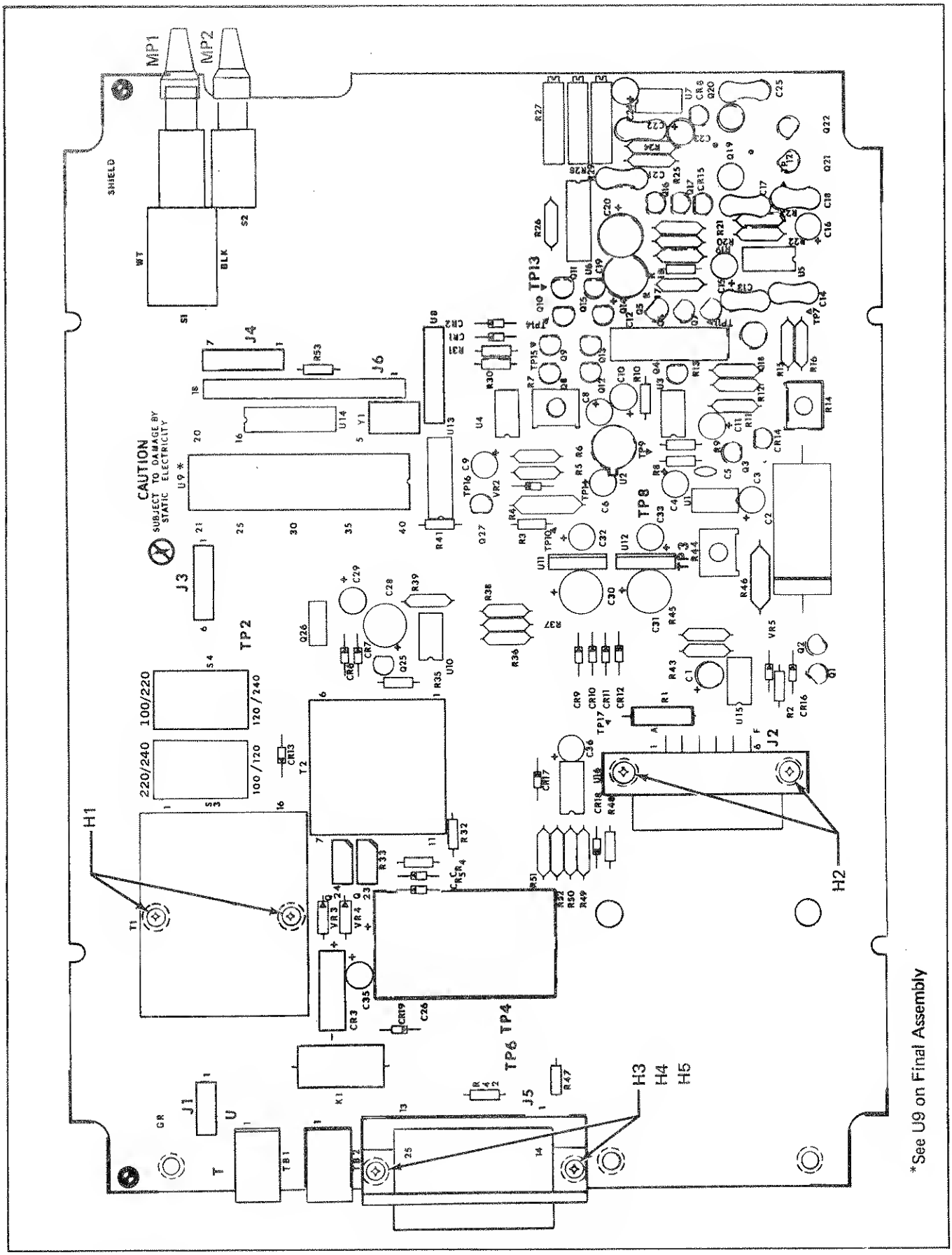


Figure 5-2. A1 Main PCB Assembly

Table 5-3. A2 Display PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	DISPLAY PCB ASSEMBLY FIGURE 5-3 (2180A-4002T)	464297	89536	464297	REF		
DS1	DIODE, LED DISPLAY, 7-SEGMENT, RED	418012	28480	5082-7651	7	2	
DS2	DIODE, LED DISPLAY, 7-SEGMENT, RED	418012	28480	5082-7651	REF		
DS3	DIODE, LED DISPLAY, 7-SEGMENT, RED	418012	28480	5082-7651	REF		
DS4	DIODE, LED DISPLAY, 7-SEGMENT, RED	418012	28480	5082-7651	REF		
DS5	DIODE LED DISPLAY, 7-SEGMENT, RED	418012	28480	5082-7651	REF		
DS6	DIODE, LED DISPLAY, 7-SEGMENT, RED	418012	28480	5082-7651	REF		
DS7	DIODE, LED DISPLAY, 7-SEGMENT, RED	418012	28480	5082-7651	REF		
P6	CABLE, FLAT, 18 POS, 6-INCH	474411	00779	1-86947-1	1		
Q1	TRANSISTOR, SI, PNP	195974	04713	2N3906	13	1	
Q2	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q3	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q4	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q5	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q6	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q7	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q8	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q9	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q10	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q11	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q12	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q13	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
R1	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	1		
R3	RES, DEP. CAR, 1 +/-5%, 1/4W	357665	80031	CR251-4-5P1E	1		
U1	IC, LIN, NPN, 5 TRANSISTOR ARRAY	418574	02735	CA3083E	1	1	
U2	RESISTOR NETWORK, 1K	407445	89536	407445	1	1	
U3	RESISTOR NETWORK, 82 OHM	478859	89536	478859	1	1	

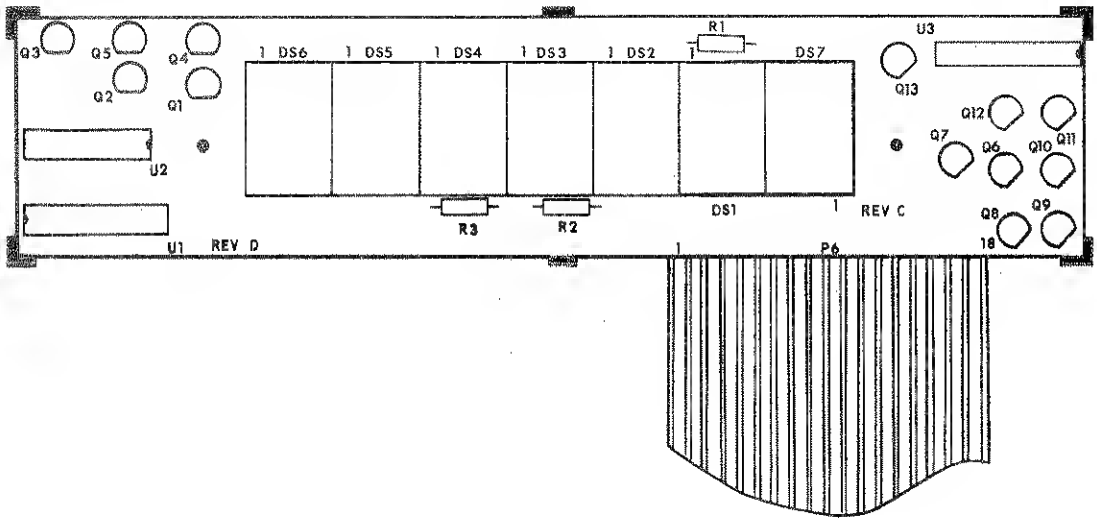


Figure 5-3. A2 Display PCB Assembly

Table 5-4. A3 RTD Input PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	RTD INPUT PCB ASSEMBLY FIGURE 5-4 (2180A-4003T)	469304	89536	469304	REF		
C1	CAP, POLYCARB, 2.2 UF +/-10%, 100V	306522	80031	C280MCH/A2M2	1		
H1	WASHER, FIBER #4	110890	12443	2508	2		
H2	LOCKWASHER, SPLIT, #4	110395	89536	110395	2		
H3	P-NUT, BROACHING, 4-40	380196	24347	KF2-440	2		
H4	SCREW, PHP, 4-40 X 3/8	403782	89536	403782	2		
R1	RES, COMP, 47K +/-5%, 1W	150219	01121	GB4735	1		
R2	RES, VAR, 500 +/-20%, 1/2W	267849	75378	190PC501B	1	1	
S1	SWITCH MODULE, DUAL-IN-LINE, SPST	408559	00079	435166-2	1		
S2-1	SWITCH, TOP HALF	454835	10389	24-420-020	2		
S2-2	SWITCH, BOTTOM HALF	454777	10389	24-410-020	2		
S3-1	SWITCH, TOP HALF	454835	10389	24-420-020	REF		
S3-2	SWITCH, BOTTOM HALF	454777	10389	24-410-020	REF		
TB1	TERMINAL BLOCK	461475	89536	461475	1		

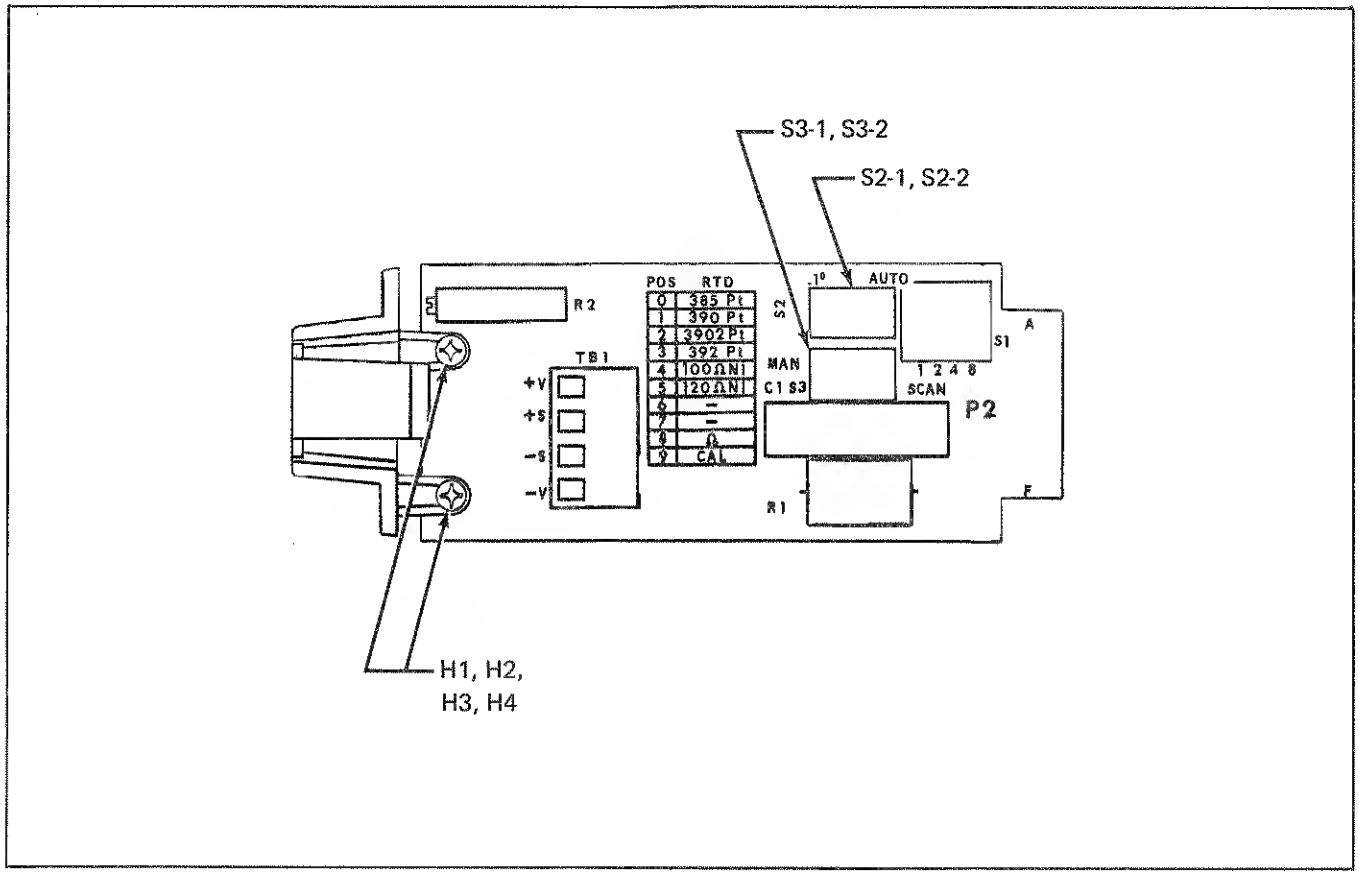


Figure 5-4. A3 RTD Input PCB Assembly

Section 6
Option & Accessory Information

TABLE OF CONTENTS

6-1. INTRODUCTION

6-2. This section of the manual contains information on the accessories and options available for the 2180A Digital Thermometer.

6-3. ACCESSORY INFORMATION

6-4. The portion of this section dealing with accessories contains the details of all accessories available for the 2180A.

6-5. OPTION INFORMATION

6-6. Each of the options available for the 2180A are described separately in a subsection identified with the option name and number. The option description contains the information on the operating instructions and maintenance not covered in the main body of the text, plus a complete list of replaceable parts for the option.

Accessories

600-1. GENERAL

600-2. Table 600-1 contains a list of the accessories available for use with the 2180A Digital Thermometer. The following paragraphs contain information on the types of accessories. Instructions for use accompany each accessory. In all cases order using the accessory number listed.

600-3. RTD MULTIPOINT SELECTOR, (Y2000)

600-4. The Multipoint Selector allows the operator to manually select and monitor the one of up to ten channels; two separate thermocouple types (maximum of five each if two types used) may be connected to the unit. Up to ten multipoint selectors may be connected in series.

600-5. ALARMS OUTPUT (Y2002)

600-6. The Alarms Output accessory provides controls to permit up to four separate limits settings, so that there is an operator indication at more than one temperature point. The four thumbwheel controls allow the simultaneous setting of a high and low, in any combination.

Table 600-1. 2180A Accessories

ACCESSORY	DESCRIPTION
Y2000	Multipoint Selector, RTD
Y2002	Alarms Output
Y2009	Battery Pack, 12V Rechargeable
Y2010	Rack Panel PTI, single, A size (for Y2000)
Y2011	Rack Panel PTI, double, A size (for Y2000)
Y2012	Rack Panel PTI, single, B size (for Y2009)
Y2013	Rack Panel PTI, double, B size (for Y2009)
Y2014	Rack Panel PTI, single, C size (for 2180A and Y2002)
Y2015	Rack Panel PTI, double, C size (for 2180A and Y2002)
Y2018	Panel Mount PTI-DIN, A size (for Y2000)
Y2019	Panel Mount PTI-DIN, 8 size (for Y2009)
Y2020	Panel Mount PTI-DIN, C size (for 2180A and Y2002)
Y2022	Divider, Thermometer Calibrator
Y2023	Accessory Case
Y2024	Power Cord, 3-way
Y2025	Probe, RTD, 100Ω, 385 Pt
Y2026	Cable, Output Unit, RS232C

600-7. BATTERY PACK, 12V RECHARGEABLE (Y2009)

600-8. The rechargeable battery pack provides the 2180A and its accessories with portability. The output is +12V dc at a maximum of 750 mA for a total of 2.2 ampere-hours.

600-9. DIVIDER, THERMOMETER CALIBRATION (Y2022)

600-10. The device is a preset 100 to 1 divider to provide the precision millivolt outputs from a DC Calibrator required for calibration. The device wires into the RTD Input PCB in place of the RTD Probe during calibration. Refer to the Y2022 Instruction manual for the schematic and additional information.

600-11. RACK PANELS

600-12. Available are rack mounting panels in three sizes and two types for the standard 19-inch electronics equipment racks. The "A" size for the Multipoint Selector is available in panels that will accomodate either one or two instruments. The "B" size panel for the Calibrator and/or Battery Pack is also available for single or double instruments, as is the "C" size used for the 2180A Thermometer and the Alarms Output.

600-13. PANEL MOUNTS

600-14. The panel mounts provide the hardware to install the instrument in any panel in which a hole the size of the instrument front panel can be cut. It is available for the three instrument sizes required, "A", "B", and "C".

600-15. ACCESSORY CASE (Y2023)

600-16. The accessory case is a "C" sized PTI case which contains a storage drawer. This provides the operator that has several instruments in a stacked group, storage space for test equipment and spare and/or alternate thermocouple probes and wires.

600-17. POWER CORD, 3-WAY (Y2024)

600-18. This accessory is a specially constructed power cord with three female and one male connectors that allow the operator to connect up to "C" size or smaller PTI instruments with one line power cord.

600-19. CABLE OUTPUT UNITS, RS232C (Y2026)

600-20. The Y2026 is an interface device which allows direct mating between any RS232C device and the -002 Output Option. The Y2026 consists of two 25-pin connectors, one 36-pin connector and an accessory cable to provide connection between the 36-pin output and the -002 Output Option. It will be necessary for the user to provide the cable between the 25-pin outputs and the RS232C devices.

Option -002
Output

602-1. INTRODUCTION

602-2. The 21X0-002 Option is an analog and digital output unit. It provides either the 2180A or 2190A Model Digital Thermometers with a recording output for a permanent record when required. Tbe option may be ordered with the unit for factory installation or is available as a kit for installation in the field.

602-3. The analog output is available on the rear panel at two flusb banana jacks with the polarity indicated. The output is a scaled voltage source of 1 millivolt per degree of temperature, regardless of the temperature scale selected, with the polarity as read on the display. For example; a reading of 251°F would output +251 mV dc; 97.3°C would output +97.3 mV dc; and -31.9°F would output -31.9 mV dc.

602-4. The digital output is a clocked message that can be in two different formats to match the requirement of the customer's equipment. Output on one set of lines is a bit-parallel, byte-serial message format designed for printer interface. Also available are the standard EIA RS232C and current loop bit-serial outputs. Both formats provide the channel number, the current reading displayed, and any out of range or open thermocouple information.

602-5. SPECIFICATIONS

602-6. Specifications for the Output Option, 21X0-002, are as listed in Table 602-1.

Table 602-1. Specifications

Analog Output
- **Type:** Linearized and isolated.
- **Voltage:** 1.0 mV/ °C or °F from -425 mV to 4.5V, 5 mA max.
- **Temperature Coefficient:** 200 ppm/ °C from 25°C.
- **Noise:** ⩽100 uV at 100 Hz bandwidth.
- **Accuracy:** ±0.1% of reading ±1 mV.
- **Zero Drift:** 200 uV/°C from 25°C,
- **Warm-Up Time:** 5 minutes, to rated accuracy.

Digital Output
- **Types:** Three, E.I.A. Standard RS-232-C Type 2, TTY current loop, and parallel ASCII.
- **Connector:** 36-pin AMP "Champ".
- **Serial Baud Rates:** 110, 150, 300, 600, 1200, 2400, 4800, 9600, switch-selectable.
- **RS-232-C Signals:** Transmitted Data, Request to Send, Clear to Send, Data Set Ready, Signal Common.
- **Parallel ASCII Signals:** Data 8 lines, instrument address 3 lines, Address Valid, Data Valid, Acknowledge, ground, +5V.
- **Parallel ASCII Data Rate:** Three readings per second.
- **Parallel ASCII Interface:** Plug-to-plug compatible with similar Fluke equipment.
- **TTY Current Loop Signals:** Source and controlled sink, 20 mA.
- **Dut-of-Limit Signal:** Exclamation point transmitted with Option 21X0-006 only; not with Y2002.
- **Battery Operation:** 4 to 5 hours typical at 25°C on fully charged Y2003 or Y2009.

602-7. INSTALLATION

602-8. Options for field installation can be installed using the following procedure:

1. Disconnect the thermometer from all input power sources.

2. Remove the screws on the bottom of the case that fasten the top and bottom of the PTI case together and remove the top half of the case.

3. Remove the center mounting screw that attaches the Main PCB to the case and lift the pcb clear of the case.

4. Attach the four spacers supplied with the option to the component side of the pcb in the holes forming a rough rectangular pattern (do not use the fifth hole on the corner, next to U1).

Table 602-2. Switch Selection

SWITCH POSITION	SWITCH BANK 1	2	3	4	S1 BAUD RATE	S2 FUNCTION	S3 ADDRESS
0	OFF	OFF	OFF	OFF	110	OPERATE	ADR 0
1	ON	OFF	OFF	OFF	150	CAL 1	ADR 1
2	OFF	ON	OFF	OFF	300	CAL 2	ADR 2
3	ON	ON	OFF	OFF	600	CAL 3	ADR 3
4	OFF	OFF	ON	OFF	1200	CAL 4	ADR 4
5	ON	OFF	ON	OFF	2400	CAL 1	ADR 5
6	OFF	ON	ON	OFF	4800	CAL 2	ADR 6
7	ON	ON	ON	OFF	9600	CAL 3	ADR 7
8	OFF	OFF	OFF	ON	110	PLOT 1	ADR 8
9	ON	OFF	OFF	ON	150	PLOT 2	ADR 9

5. Reinstall the Main PCB in the bottom half of the case.

6. On the Output Unit PCB use Table 602-2 and S1 to select the desired BAUD rate, select position 0 on the Function switch S2, and select the PTI Bus Address using S3.

7. Connect the Output Unit cables to the connectors on the Main PCB.

8. Attach the Output Unit PCB to the spacers, component side down, and the connector to the rear panel access port.

9. Replace the PTI cover on the instrument and reconnect the input power sources, if required, at this time.

602-9. OUTPUT CONNECTIONS

602-10. All connections between the Output Unit Option and external instruments are made using the rear panel connectors previously described. The analog output is from standard banana jacks. The digital output female connector has a mating male connector accompanying the option. This allows the customer to custom make a cable between the thermometer output option and the receiving device. Table 602-3, is the pin-out data for the digital output connector.

NOTE

Standard RS232C signals are output on 25-pins, the connector on the -002 Output Option is 36-pins, therefore, the user must either hardwire the connection between the -002 Output Option or order the Y2026, Cable Adapter.

Table 602-3. Digital Output Connector Pin-Out

PIN NO.	FUNCTION	MNEMONIC	USE
1	Address Valid	ADRVAL	PTI Bus
2	Data Valid	DATVAL	PTI Bus
3-6	Printer Address	A0-A3	PTI Bus
7	Acknowledge	ACK	PTI Bus
8	Not Used		
9-16	Data	D0-D7	PTI Bus
17	Ground		PTI Bus
18	+5 Volts		PTI Bus
19-24	Not Used		
30	Transmitted Data		RS232 Interface
31	Request to send		RS232 Interface
32	Clear to send		RS232 Interface
33	Data set ready		RS232 Interface
34	Signal Common		RS232 Interface
35	S0+		Current Loop
36	S0–		Current Loop

602-11. OPERATION

602-12. Once the Output Unit Option is installed, the only operator functions deal with the connection of external equipment to the analog or digital output connectors.

602-13. The positive and negative analog terminals have available a dc millivolt output with the same polarity, and proportional to the temperature displayed. For example, if the thermometer displayed +105.7°F the analog output would be +105.7 mV dc and for –53.1°C the output would be –53.1 mV dc. The full resolution of the temperature display (tenths or hundredths of degrees) is reflected on the output.

602-14. The digital output can be connected to a printer or any device accepting parallel ASCII data, or to a device accepting RS232C or Current Loop signals. Connections for all three types of signals are available simultaneously on the 36-pin output connector previously described.

602-15. THEORY OF OPERATION

602-16. The Output Unit Option converts the temperature displayed by the output into a format usable by the customer's equipment. The output may be available as a scaled analog voltage or as formatted parallel and serial ASCII digital output. The following paragraphs describe operation of the Accessory Bus that handles communication between the instrument and the options, the analog output circuitry and the digital output circuitry. Refer to the schematic in Section 8 during the following discussion.

602-17. Accessory Bus Communication

602-18. The option communicates with the thermometer on the clocked bit-serial accessory bus. Transmitted on the bus are channel number, range, conversion type, scale, and digits of the temperature reading. When the WRTADR line is held low, DCLK clocks the address of the Output Unit (4), followed by the thermometer data to the microprocessor on the DATA line. Once into the microprocessor, the data is converted, formatted, and output to the analog and digital output circuitry.

602-19. Analog Circuitry

602-20. The temperature reading received by tbe microcomputer is used to generate an integrate control signal, the length of which is proportional to the magnitude of the temperature reading. This signal is used to turn on (close) the FET switches Q6 and U12-2, open the switches U11-2, U11-3 and U12-3, and set the output polarity with switches at U12-9 and U12-10. (U12-9 is closed when a negative reading is being processed and U12-10 when a positive signal is being processed.)

602-21. With Q6 on, the capacitor C1 is charged linearly to a voltage proportional to the length of the control signal at Q6. When Q6 has been on for the time required, it is opened, and switch U11-13 is closed, so the output of U13-8 can be sampled and held on C2. After 10 ms switch U11-3 opens and switch U11-11 closes to zero the integrate capacitor C1, until the next conversion cycle.

602-22. The voltage held on C2 is buffered by U13-7. U13-14 either passes the voltage directly to the output stage, or amplifies it as controlled by switches U12-9 and U12-10, which alternate states to set the polarity. The output stage at U13-1 has a constant gain of –1.

602-23. Digital Output Circuitry

602-24. The thermometer reading transmitted on the accessory bus every 333 ms is formatted by the microcomputer and, if requested, made available on the PTI Bus, RS232C, and current loop outputs. Refer to the schematics in Section 8 during the following description.

602-25. Eight data, four address, a data valid, an address valid, and an acknowledge line are used by the PTI Bus Interface. The external device requests data from the Output Unit by applying the preselected address to the address lines. The address is preselected by setting switch S3 to the desired number (0-9). When the proper address is decoded the tri-state output buffers (U8 and U9) are enabled, and the microcomputer and external device notified that the Output Unit has a valid address. When the conversion process is complete, the microcomputer applies the first character of the formatted data to the output lines and pulls the DATVAL line low. The external device reads the data and pulls the ACK line low, causing the Output Unit to reply with a new character. The process is repeated until data transfer is complete. The message formats are shown in Figure 602-1.

602-26. After transfer to the printer lines is complete, the microcomputer checks the DATA SET READY and CLEAR TO SEND lines from the RS232C Interface. If both lines are high, the same message as was output on the print lines is output on the RS232C and current loop lines in a bit-serial format. Since the thermometer cycle rate of 333 ms is shorter than the time required to output data at BAUD rate of 1200 and less, a message is not transmitted during every instrument cycle.

602-27. CALIBRATION

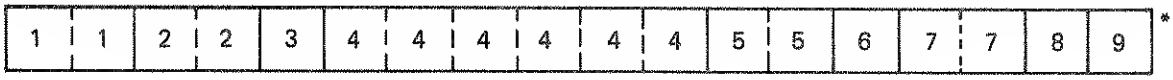
602-28. Analog circuitry in the option should be calibrated every 90 days or after any repair of the unit. The procedure following assumes that power is supplied to the unit and that a Digital Voltmeter capable of reading 10 μV on the 1 volt, or equivalent range, i.e., a Fluke Model 8800A, is available.

1. Remove power from the instrument.

2. Remove the top cover from the thermometer.

3. Remove the screws attaching the option pcb to the Main PCB.

4. Leaving the interconnect cables connected, turn the option pcb to the right, while facing the instrument, exposing the component side and making the switches and adjustment accessible.



1 Two digit channel number

2 Two blanks

3 Sign – plus or minus

4 Five Digit Numeric with a decimal point for either tanths or hundreds

5 Two character temperatura scale. Either °C or °F on PTI Bus and either blank C or blank F on RS 232C, the degrae symbol (°) is transmitted to the printer as a "d".

6 Character "!" when preset limits are exceeded. Ona blank if signal within limits

7 Two character display – "OL" for overload, "OC" for open circuit or open thermocouple or two blanks if operating normally

8 Carriage return

9 Line Feed

NOTE
This eighteen character ASCII coded message can be sent as; ASCII parallel, RS232C, or Current Loop.

*Each block represents one ASCII character. The parity bit is always sent as zero.

Figure 602-1. Message Format

5. Connect the DMM to the Analog Output Connector.

6. Apply power to the instrument and allow if to warm-up for a minimum of 5 minutes.

7. Set the FUNCTION switch (S2) to position 1 (CAL 1).

8. Adjust R26 for an output of 0 ± 0.1 mV dc.

9. Set the FUNCTION switch to position 2 (CAL 2).

10. Adjust R26 for an output of 0 ± 0.1 mV dc.

11. Set FUNCTION switch to position 3 (CAL 3).

12. Adjust R11 for an output of -10V ± 1 mV dc.

13. Set FUNCTION switch to position 4 (CAL 4).

14. Adjust R19 for an output of +10V ± 1 mV dc.

15. Remove power and the test DMM, then reinstall the option pcb on the Main PCB and the top cover on the instrument.

602-29. TROUBLESHOOTING

602-30. Troubleshooting for the 2180A Option -002, Output Unit, consists of the tabular flow chart in Table 602-4. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

602-31. LIST OF REPLACEABLE PARTS

602-32. Table 602-5 is a list of replaceable parts for the Output Option. Refer to Section 5 for an explanation of the columnar entries.

Table 602-4. Output Option Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE ***These tests are based on the assumption that the 2180A/2190A has been thoroughly checked out and is free of troubles prior to beginning the test of the Output Option –002.***		
1	Obtain a reading on the 2190A (the input can be shorted for a display of approximately the ambient temperature).		
2	Is the Output option's analog output equal to the 1 mV per degree specified?	16	3
3	From pin 20 (common isolated) on U7 is there +5 volts to pin 40 of U7, +15 volts to pin 4 of U13, and –15 volts to pin 11 of U13?	5	4
4	Check for a 12V dc input at P1 pins 1 and 4, an≈ 20 kHz squarewave from T1 pin 8 to pins 7 and 9, >5.5V at the emitter of O12, >17.5V at the input of U19, and <17.5V at the input of U20. Repair as required then resume at step 1.		
5	Are the signals at pins 24, 25, and 38 of U7 toggling (vary between a logic high and logic low)?	7	6
6	Check the input, cabling and U1 if all signals are absent. Check the individual line's components if one is absent. Repair as required then resume at step 1.		
7	Are the signals at pins 10 through 15 of U7 toggling?	9	8
8	Check U7 and its clock input from Y1 (4 MHz and opposite in phase from common to pin 1 and 2). Repair as required then resume at step 1.		
9	Are the following signals on U6 as stated: pins 5 and 11 toggling; pins 1 and 3 opposite, and reverse when the output sign is changed; pin 13 low except in CAL 1 position; and pin 9 varying with the length of charge time?	11	10
10	Check U5 and U6. Repair as required then resume at step 1.		
11	Is the signal at the gate of FET switch Q6 toggling between common and –15V?	13	12
12	Check Q14, CR17 and their associated components. Repair as required then resume at step 1.		
13	Perform the Output Option Calibration procedure.		
14	Are all points adjustable within the stated tolerance?	16	15
15	Check the components associated with each adjustment. Since the ICs U11, U12, and U13 are multi-parts units they effect all circuits. Repair as required then resume at step 1.		
16	Obtain a reading and vary the BAUD rate selection switch through its range while observing the output at each BAUD rate setting.		
17	Is the data transmitted correctly at all BAUD rates?	34	18
18	Is the data transmitted correctly at one or more BAUD rates?	19	20
19	Check the BAUD rate selection switch S1. Repair as required then resume at step 16.		
20	Are CLEAR TO SEND (CTS) and DATA SET READY (DSR) at U7-8 and U7-9 respectively at a logic low?	22	21

Table 602-4. Output Option Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *This is with a receiving device attached. If not attached tie pins 32 and 33 of J7 high to simulate an accepting device.*		
21	Check the interface from the RS232 device, Q8, Q9 and their associated components. Repair as required then resume at step 16.		
22	Is the signal at pin 3 of U7 toggling?	24	23
23	Check U7. Repair as required then resume at step 16.		
24	Does the signal at pin 30 of J7 in reference to pin 34 of J7 toggle while a message is transmitted?	26	25
25	Check Q4, Q5, U18, and their associated components. Repair as required then resume at step 16.		
26	Is the output data available on the PTI Bus?	26	27
27	Is the signal at U10-6 low?	29	28
28	Verify that the input address and address switch setting are the same. Check the address decoding circuit in U10, U16, U17, U15, U21, S3 and their associated components. Repair as required then resume at step 26.		
29	Is $\overline{\text{ADRVAL}}$ low at pin 1 of J7?	31	30
30	Check the tri-state buffer U8 and it's enabling signal. Repair as required then resume at step 26.		
31	Do the $\overline{\text{DATVAL}}$, $\overline{\text{ACK}}$ and D0 through D7 signals on pins 2, 7, and 9 through 16 of J7 respectively toggle?	33	32
32	Check the tri-state buffers U8 and U9, the microprocessor U7, and the $\overline{\text{ACK}}$ input from the PTI 8us. Since the the RS232 output has already been checked, the input to U7 has been verified. Repair as required then resume at step 26.		
33	Check the connector, interconnecting cable and receiving device. Repair as required then resume at step 26.		
34	Troubleshooting of the Output Option is complete.		

Table 602-5. A4 Output Option PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
002	⌀ OUTPUT OPTION-002 PCB ASSEMBLY FIGURE 602-2 (2180A-4020T)	-002	89536	2190A-002	REF		
C1	CAP, POLYSTRN, 0.56 UF +/-10%, 100V	284851	89536	284851	1		
C2	CAP, POLYPRPLN, 0.47 UF +/-10%, 50V	363085	89536	363085	1		
C3	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	1		
C4	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	8		
C5	CAP, TA, 39 UF +/-20%, 20V	358234	56289	196D396X0020PE4	1		
C6	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C7	CAP, TA, 22 UF +/-20%, 35V	394775	56289	196D226X0035TE4	2		
C8	CAP, TA, 22 UF +/-20%, 35V	394775	56289	196D226X0035TE4	REF		
C9	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C10	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C11	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C12	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196105X0035JA1	2		
C13	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C14	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C15	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C16	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196105X0035JA1	REF		
C17	CAR, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B10H253M	1		
CR1	DIODE, ZENER	393579	07910	1N4567	1	1	
CR3	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	10	2	
CR4	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR5	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR6	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR7	DIODE, ZENER, 36V	186163	07910	1N974B	2	1	
CR8	DIODE, ZENER, 36V	186163	07910	1N974B	REF		
CR9	DIODE, SI, RECTIFIER	379412	04713	1N4933	2	1	
CR10	DIODE, SI, RECTIFIER	379412	04713	1N4933	REF		
CR11	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR12	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR13	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR14	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR15	DIODE, ZENER, 6.2V	325811	07910	1N752A	1	1	
CR16	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR17	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
H1	SCREW, PHP, 4-40 X 3/8 (NOT SHOWN)	152124	73734	19024	2		
H2	LOCKWASHER (NOT SHOWN)	110395	89536	110395	2		
H3	NUT, HEXAGON (NOT SHOWN)	147611	89536	147611	2		
H4	HARDWARE KIT (FOR J7)	435750	00779	552565-1	1		
J7	CONNECTOR	414409	00779	552241-1	1		
J8	JACK, INPUT	492314	89536	492314	2		
P1	CABLE, JUMPER	474148	00779	86942-3	1		
P3	CABLE, JUMPER	474155	00779	86942-5	1		
Q1	TRANSISTOR, SI, NPN	218396	04713	2N3904	8	2	
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q3	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q4	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q5	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q6	TRANSISTOR, FET, N-CHANNEL	429977	89536	429977	1	1	
Q7	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	1	1	

Table 602-5. A4 Output Option PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q8	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q9	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q10	TRANSISTOR, SI, NPN, PWR	477331	04713	MDS01A	REF		
Q11	TRANSISTOR, SI, NPN, PWR	477331	04713	MDS01A	REF		
Q12	TRANSISTOR, SI, PNP, PWR	473207	01295	T1P30	1	1	
Q13	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q14	TRANSISTOR, SI, PNP	195974	04713	2N3906	1	1	
R1	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	12		
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R4	RES, DEP. CAR, 220K +/-5%, 1/4W	348953	80031	CR251-4-5P220K	3		
R5	RES, DEP. CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2	4		
R6	RES DEP. CAR, 220K +/-5%, 1/4W	348953	80031	CR251-4-5P220K	REF		
R7	RES, DEP. CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2	REF		
R8	RES, DEP. CAR, 220K +/-5%, 1/4W	348953	80031	CR251-4-5P220K	REF		
R9	RES, DEP. CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2	REF		
R10	RES, MTL. FILM, 16.9K +/-1%, 1/8W	267146	91637	CMF551692F	1		
R11	RES, VAR, 25K +/-20%, 1/2W	285213	75378	190PC2538	1	1	
R12	RES, MTL. FILM, 102K +/-1%, 1/8W	291286	91637	CMF551023F	1		
R13	RES, MTL. FILM, 2K +/-1%, 1/8W	235226	91637	CMF552001F	1		
R14	RES, MTL. FILM, 750K +/-1%, 1/8W	271361	91637	CMF55751F	2		
R15	RES, VAR, 100K +/-20%, 1/2W	268581	75378	190PC104B	2	1	
R16	RES, MTL. FILM, 60.4K +/-1%, 1/8W	291419	91637	CMF556042F	2		
R17	RES, MTL. FILM, 60.4K +/-1%, 1/8W	291419	91637	CMF556042F	REF		
R18	RES, MTL. FILM, 3.92K +/-1%, 1/8W	294801	91637	CMF553921F	2		
R19	RES, VAR, 100 +/-10%, 1/2W	275735	11236	360T-101A	1		
R20	RES, MTL. FILM, 3.92K +/-1%, 1/8W	294801	91637	CMF553921F	REF		
R21	RES, MTL. FILM, 10K +/-1%, 1/8W	168360	91637	CMF551002F	3		
R22	RES, MTL. FILM, 10K +/-1%, 1/8W	168360	91637	CMF551002F	REF		
R23	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	2		
R24	RES, MTL. FILM, 750K +/-1%, 1/8W	271361	91637	CMF55751F	REF		
R25	RES, MTL. FILM, 1K +/-1%, 1/8W	168229	91637	CMF551001F	1		
R26	RES, VAR, 100K +/-20%, 1/2W	268581	75378	190PC104B	REF		
R27	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R28	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R29	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R30	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R31	RES, DEP. CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2	REF		
R32	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R33	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R34	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R35	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	1		
R36	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R37	RES, DEP. CAR, 240 +/-5%, 1/4W	376624	80031	CR251-4-5P240E	1		
R38	RES, DEP. CAR, 3.9K +/-5%, 1/4W	342600	80031	CR251-4-5P3K9	1		
R39	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8	2		
R40	RES, DEP. CAR, 4.3K +/-5%, 1/4W	441576	80031	CR251-4-5P4K3	1		
R41	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8	REF		
R42	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3	1		
R43	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	1		

Table 602-5. A4 Output Option PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R44	RES, MTL. FILM, 1.02K +/-1%, 1/8W	223545	91637	CMF551021F	1		
R45	RES, MTL. FILM, 10K +/-1%, 1/8W	168360	91637	CMF551002F	REF		
R46	RES, MTL. FILM, 9.09K +/-1%, 1/8W	221663	91637	CMF559091F	1		
R47	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R48	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R49	RES, MTL. FILM, 4.32K +/-1%, 1/8W	294819	91637	CMF554321F	1		
R50	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R51	RES, DEP. CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39K	1		
R52	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	1		
R53	RES, MTL. FILM, 64.9K +/-1%, 1/8W	288530	91637	CMF556492F	1		
R54	RES, MTL. FILM, 226K +/-1%, 1/8W	320879	91637	CMF552263F	1		
R55	RES, MTL. FILM, 309K +/-1%, 1/8W	235283	91637	CMF553093F	1		
S1	SWITCH MODULE, SPST	408559	00779	435166-2	3		
S2	SWITCH MOOULE, SPST	408559	00779	435166-2	REF		
S3	SWITCH MOOULE, SPST	408559	00779	435166-2	REF		
T1	TRANSFORMER, DC-DC CONV	461954	89536	461954	1		
U1	Ⓐ IC, C-MOS, HEX BUFFER/INVERTER	381830	04713	MC14050CP	1	1	
U2	OPTO-ISOLATOR	380014	01295	T1L116	3	1	
U3	OPTO-ISOLATOR	380014	01295	T1L116	REF		
U4	OPTO-ISOLATOR	380014	01295	T1L116	REF		
U5	RES, NETWORK	413286	89536	413286	1	1	
U6	Ⓐ IC, C-MOS, HEX, OPEN ORAIN BUFFERS	473389	12040	MM74C906N	1	1	
U7	Ⓐ IC, MICROPROCESSOR, MOS	495309	04713	MC3870/14	1	1	
U8	Ⓐ IC, C-MOS, TRI-STATE, HEX, NON-INV BUFF	407759	04713	MC14503CP	2	1	
U9	Ⓐ IC, C-MOS, TRI-STATE, HEX, NON-INV BUFF	407759	04713	MC14503CP	REF		
U10	Ⓐ IC, C-MOS, HEX INVERTERS	404681	04713	MC1406BCP	1	1	
U11	Ⓐ IC, C-MOS, QUAO, BI-LATERAL SW	363838	02735	C04016AE	2	1	
U12	Ⓐ IC, C-MOS, QUAD, BI-LATERAL SW	363838	02735	CD4016AE	REF		
U13	IC, LINEAR, OP-AMP, J-FET INPUT	483438	89536	483438	1	1	
U14	TRANSISTOR, J-FET, N-CHANNEL	460014	89536	460014	1	1	
U15	RES, NETWORK	412726	89536	412726	2	1	
U16	Ⓐ IC, C-MOS, QUAO, EXCLUSIVE OR	355222	02735	C04030AE	1	1	
U17	Ⓐ IC, C-MOS, DUAL 4-INPUT, NOR GATE	363820	04713	MC14025CP	1	1	
U18	IC, LINEAR, OP-AMP, J-FET INPUT	454454	89536	454454	1	1	
U19	IC, LINEAR, VOL REG, FXD	413187	04713	MC7815CP	1	1	
U20	IC, LINEAR, NEG, VOL REG	413179	04713	MC7915CT	1	1	
U21	RES, NETWORK	412726	89536	412726	REF		
U22	IC, LINEAR, LO-PWR DUAL VOL COMP	478354	12040	LM393N	1	1	
XU7	SOCKET, IC, 40-PIN	418988	91506	340-AG39D	1		
XU14	SOCKER, IC, 8-PIN	478016	91506	308-AG39D	1		
Y1	CRYSTAL	474072	89536	474072	1		

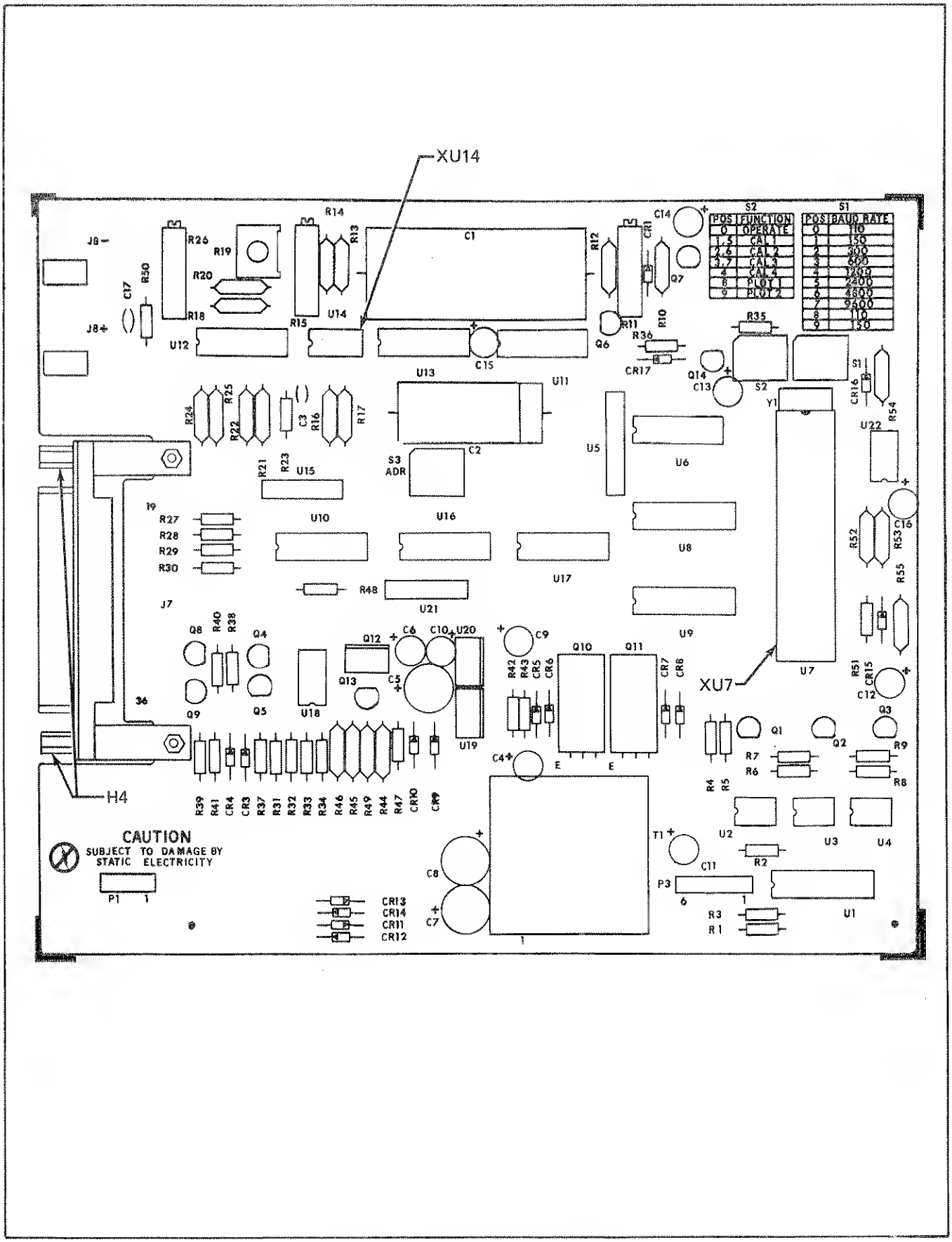


Figure 602-2. A4 Output Option PCB Assembly

Option -006
Limits

606-1. INTRODUCTION

606-2. The 21X0-006 Limits Option gives the 2180A and 2190A Digital Thermometers the capability of providing hoth visual and electrical indications (alarms) when the temperature measurement exceeds either of a pair of selectable maximum/minimum limit values. Also selectable are, all for a single point, the delta function (displays the difference between the preset value and the temperature read), and the maximum/minimum display function (the highest or lowest temperature read since the last reset by the INITIALIZE MAX/MIN switch).

606-3. The Limits Option is available as factory installed with initial order or may be ordered as a field installable kit for addition to the instrument.

606-4. SPECIFICATIONS

606-5. Specifications for the Limits Option, 21X0-006, are as listed in Table 606-1.

Table 606-1. Specifications

Limits Function: lights LED and activates Form A (SPST) relay when a preset limit is exceeded. Contacts rated at 10 VA, 184V dc or 130V ac rms max, 0.5A max, resistive.
Min/Max Function: Store min or max readings, resettable from front panel.
△ Temperature Function: Reads ± temperature deviations from preset nominal temperature.
Installable: Factory or field, through pre-punched front panel.

Function:	Limit:
≤ Low Limit	−9999°
> High Limit	+9999°
Store min reading	Not used
Store max reading	Not used
△ ± Deviation from	Nominal

606-6. INSTALLATION

606-7. Options for field installation can be installed using the following procedure:

WARNING

HAZARDOUS VOLTAGES MAY BE PRESENT WITHIN THE INSTRUMENT. ONLY QUALIFIED PERSONNEL SHOULD PERFORM THIS INSTALLATION PROCEDURE.

1. Disconnect the thermometer from all power sources.

2. Remove the screws on the bottom of the case that fasten the top and bottom of the PTI case together and remove the top half of the case.

3. Remove the hole plugs from the Limits section of the front panel and attach the standoffs supplied with the option to the front panel.

4. Position the Limits PCB so that the thumbwheel LED and pushhutton switch line up with the applicable front panel ports.

5. Attach the Limits PCB to the Main PCB using the screws supplied with the option.

6. Connect the cable on the Limits PCB to J4 on the Main PCB.

7. Replace the PTI cover on the instrument and reconnect to input power sources, if required, at this time.

606-8. OPERATING NOTES

606-9. Installation of the Limits Option enables the low current single contact relay (K1) on the thermometer Main PCB. The contact points are available on a rear panel connector block.

NOTE

Once installed, there are no provisions for disabling the Limits Option. If a temperature display is desired without the relay or LED indications, select one of the Limits functions (> or ≤) and the maximum setting on the numeric thumbwheel switches.

606-10. OPERATION

606-11. The position and general description of the Limits Option front panel controls is given in Section 2. A more detailed description of the three functions is given in the following paragraphs. The term "thermocouple" = "RTD" for the 2180A.

606-12. Limits Function

606-13. The Limits function is enabled when the function portion of the thumbwheel is set in either the ≤ or > position. The front panel LED illuminates and the rear panel relay contacts close when either of the preset conditions are met. In the greater than (>) function the indications (LED and relay contacts) result from any temperature reading that exceeds the value set on the limits thumbwheels. The less than (≤) function gives its indication when the temperature read by the thermometer is equal to, or less than, the value set on the limits thumbwheels. The thumbwheel LSD is a whole number, fractional entries cannot be made.

606-14. Delta Function

606-15. When the Delta (Δ) function is selected on the thumbwheel the thermometer display reads the difference between the temperature at the thermocouple and the whole number setting of the thumbwheels. The formula used for the computation is:

T displayed = T at thermocouple - T thumbwheel setting (in degrees)

606-16. MINIMUM/MAXIMUM Display Function

606-17. The microcomputer acculmulates and stores the highest and lowest temperatures recorded since the last reset. When the Maximum (⤒) function is selected the highest temperature recorded and stored in the microcomputer is displayed. Selection of the Minimum function (⤓) displays the lowest recorded temperature since the last reset. To record the current temperature for either function, select the applicable function and depress the front panel reset switch.

606-18. THEORY OF OPERATION

606-19. The -006 Option supplies the thermometer with the function and numeric data selected on the front panel mechanical thumbwheel switches. When a Limits function is selected, the data is stored for comparison on the option pcb. All communication between the option and the thermometer is done on the clocked serial accessory bus. This bus transmits and receives addresses, thumbwheel data, reset data, and limit status. Refer to the schematic in Section 8 during the Theory of Operation discussion.

606-20. Addressing

606-21. Each of the options on the bus is addressed with a different code. The thermometer uses the address "6" to talk to the Limits Option. To talk to any option the $\overline{\text{WRTADR}}$ (P4-3) line must be brought low, with $\overline{\text{WRT}}$ (P4-4) high, followed by the applicable four address bits applied to the $\overline{\text{DATA}}$ (P4-5) line in succession, toggling $\overline{\text{DCLK}}$ (P4-6) for each bit. This clocks the address into the shift register (U2-15) where it is compared to the Limits Option address and, if valid, (U1-1 low) enables the gates required to shift data to the thermometer (U5-11) and into the Limits Option (U5-2). Details of the data transfer are in subsequent paragraphs.

606-22. Limits Option Outputs

606-23. Before the thermometer can input data from the Limits Option, the Limits circuitry must be addressed as described previously (U1-1 low). Once addressed the $\overline{\text{WRTADR}}$ and $\overline{\text{WRT}}$ lines go high. The low to high transition of $\overline{\text{WRTADR}}$ (U3-6) loads the shift registers from the thumbwheels and RESET switches. The two lines enable the output data line (U1-13) and as the thermometer accepts the data it clocks the serial output shift registers with $\overline{\text{DCLK}}$, transferring the data from the shift register to the thermometer.

606-24. In the thermometer the data is processed by the microcomputer to perform the proper action. For the Limits function the output is compared to the state of the limits and, if exceeded, the indicator illuminated and the relay energized. For the Delta function the temperature is compared against the transmitted value and the difference displayed. If either the Maximum or Minimum function is selected the stored value is displayed, but, in addition, the status of the RESET switch is checked.

606-25. Limits Option Inputs

606-26. The thermometer transmits to the Limits Option only the Limits Exceeded status. After the option has been addressed (U1-1) $\overline{\text{WRTADR}}$ goes high to

disable the addressing circuit (U4-13) while $\overline{WRT}$ stays low to enable the Limits Exceeded input (U5-8) so that $\overline{DCLK}$ can clock the data into the latch (U5-1). A Limits Exceeded indication clocks a high into the latch resulting in a low at the output (U6-12) to turn on CR1. The limit not exceeded or another function selected, loads a low into the latch to turn off the indicator.

606-27. CALIBRATION

606-28. The Limits Option has no variable components and does not require calibration.

606-29. TROUBLESHOOTING

606-30. Troubleshooting for the 2180A Option -006, Limits, consists of the tabular flow chart in Table 606-1. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

606-31. LIST OF REPLACEABLE PARTS

606-32. Table 606-2 is a list of replaceable parts for the Limits Option. Refer to Section 5 for an explanation of the columnar entries.

Table 606-2. Limits Option Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *These tests are based on the assumption that the 2180A/2190A has been thoroughly checked out and is free of troubles prior to beginning the test of the Limits Option –006.*		
1	Select the less than or equal function (≤) and set the thumbwheels for a numeric such that the thermocouple input exceeds the preset numeric (e.g., thumbwheels set at +1111 and the ambient temperature used as the thermocouple input).		
2	Does the LIMIT indicator illuminate and the rear panel relay contacts close?	26	3
3	Is the +4 Vdc input from the Main PCB present?	5	4
4	Check the +5 Vdc input, repair as required then resume at Step 1.		
5	Does the signal at U1-1 toggle (vary between logic high and logic low) when viewed with a scope?	13	6
6	Do the $\overline{WRT}$, $\overline{WRTADR}$ and $\overline{DCLK}$ lines toggle?	8	7
7	Check the inputs on the cable from the microprocessor on the Main PCB. Repair as required then resume at Step 1.		
8	Does the $\overline{DATA}$ line toggle?	10	9
9	Check the cabling and Q1, Q2, U3-8 and their associated components. Repair as required then resume at Step 1.		
10	Are the clock and data signals present at pins 1 and 15 of U2, respectively?	12	11
11	Check U1, U2-2, 11, 12, 13 and U3. Repair as required then resume at Step 1.		
12	Check U4 for the clock and U6 for loading of the data line. Repair as required then resume at Step 1.		
13	Is the function code (≤) a BCD 0 with pins 4, 5, and 6 of U7 low, the sign (+) at U7-7 high, the numeric MSD BCD code as set at pins 1, 15, 14 and 13 of U9, the second MSD BCD code as set at pins 4, 5, 6, and 7 of U11?	15	14
14	Check the switches and their associated components. Reapir as required then resume at Step 1.		
15	Is the clock present at U7-10, U9-10, and U11-10?	17	16
16	Check U4-10, U1-13 and their inputs. Repair as required then resume at Step 1.		

Table 606-2. Limits Option Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
17	Does the signal at U11-3, U9-3, and U7-3 toggle?	19	18
18	Check U11, U9, end U7. Repeir as required then resume et Step 1.		
19	Does the $\overline{\text{DATA}}$ line toggle?	21	20
20	Check O1, Q2, U3, U5-10 and their associated components. Repair as required then resume et Step 1.		
21	Are the clock and data signals present at pins 11 end 9 of U6, respectively?	23	22
22	Check U5 for the clock, repair as required then resume at Step 1.		
23	Is the collector of Q9 low?	25	24
24	Check Q9, Q3, U6-12 and their associated components. Repair as required then resume at Step 1.		
25	Check the indicator CR1 and the relay on the Main PCB. Repair as required then resume at Step 1.		
26	Set the FUNCTION switch to greater than (>) and input a temperature from the thermocouple that exceeds the preset limit.		
27	Does the LIMIT indicator illuminate and the relay contacts close?	29	28
28	Check for a Function BCD code of 1 (001) at pins 4, 5, and 6 of U7. The sign at U7-7 is high for plus and low for minus. Check that the thumbwheel switches reflect the BCD codes set on them. Repair as required then resume at Step 1.		
29	Set the FUNCTION switch to the Delta (△) position and set the thumbwheels to the desired base.		
30	Is the difference between the thermocouple input and the preset base displayed?	32	31
31	Check for a Function of BCD code of 2 (010) at pins 4, 5, and 6 of U7. Check that the thumbwheel switches reflect the BCD codes set on them. Repair as required then resume at Step 29.		
32	Set the FUNCTION switch to the minimum (⤓) position and depress the INITIALIZE MIN/MAX switch.	i n	
33	Does the thermometer display reflect the lowest temperature input from the thermocouple since the switch was depressed?	35	34
34	Check for e Function 8CD code of 3 (011) et pins 4, 5, end 6 of U7. Check U2-4 and 5, U4-3 and 4, U6-1, the initielize switch S7 end their associeted components. Repair as required then resume at Step 32.		
35	Set the FUNCTION switch to the MAXIMUM (⤒) position and depress the INITIALIZE MIN/MAX switch.		
36	Does the thermometer dlspley reflect the highest temperature input from the thermocouple since the switch was depressed?	38	37
37	Check for a Function BCD code of 4 (100) at pins 4, 5, and 6 of U7. Repair as required then resume at Step 35.		
38	Troubleshooting of the 21X0-006 Limits Option is complete.		

Table 606-3. A5 Limits Option PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
006	Ⓟ LIMITS OPTION-006 PCB ASSEMBLY FIGURE 606-3 (2180A-4060T)	-006	89536	2190A-006	REF		
CR1	LED, RED	385914	09214	SSL-22	1	1	
MP1	LED, STANDOFF ASSY (NOT SHOWN)	472548	89536	472548	1		
P4	CABLE	474379	00779	86946-6	1		
Q1	TRANSISTOR, SI, PNP	195974	04713	2N3906	1	1	
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904	3	1	
Q3	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q9	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
R1	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	6		
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R4	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R5	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
R6	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R7	RES, DEP. CAR, 240 +/-5%, 1/4W	376624	80031	CR251-4-5P240E	1		
R8	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R9	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	1		
R10	RES, DEP. CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2	1		
S1-6	THUMBWHEEL SWITCH ASSEMBLY	472803	89536	472803	1		
S7-1	PUSHBUTTON, BLUE (NOT SHOWN)	472332	89536	4723322	1		
S7-2	SWITCH COVER (NOT SHOWN)	401299	89536	401299	1		
S7-3	SWITCH ACTUATOR (NOT SHOWN)	412106	89536	412106	1		
S7-4	SWITCH SPRING (NOT SHOWN)	414516	00779	62312	1		
S7-5	SWITCH CONTACT (NOT SHOWN)	416875	00779	62313	1		
U1	Ⓟ IC, C-MOS, DUAL 4-INPUT, POS NAND GATE	355206	04713	MC14012CP	1	1	
U2	Ⓟ IC, C-MOS, DUAL 4-BIT STATIC SHIFT RESTR	340125	04713	MC14015BCP	1	1	
U3	Ⓟ IC, C-MOS, HEX INVERTER	404681	04713	MC1406BCP	1	1	
U4	Ⓟ IC, C-MOS, 3-INPUT, INV NOR GATE	355172	04713	MC14001CP	1	1	
U5	Ⓟ IC, C-MOS, 3-INPUT, NOR GATE	355180	04713	MC14025CP	1	1	
U6	Ⓟ IC, C-MOS, DUAL, D-TYPE F/F	340117	04713	MC14013CP	1	1	
U7	Ⓟ IC, C-MOS, 8-STAGE, STATIC SHIFT REGSTR	380766	12040	MM5621AN	3	1	
U8	RES, NETWORK, 100K	412908	89536	412908	3	1	
U9	Ⓟ IC, C-MOS, 8-STAGE, STATIC SHIFT REGSTR	380766	12040	MM5621AN	REF		1
U10	RES, NETWORK, 100K	412908	89536	412908	REF		1
U11	Ⓟ IC, C-MOS, 8-STAGE, STATIC SHIFT REGSTR	380766	12040	MM5621AN	REF		1
U12	RES, NETWORK, 100K	412908	89536	412908	REF		1

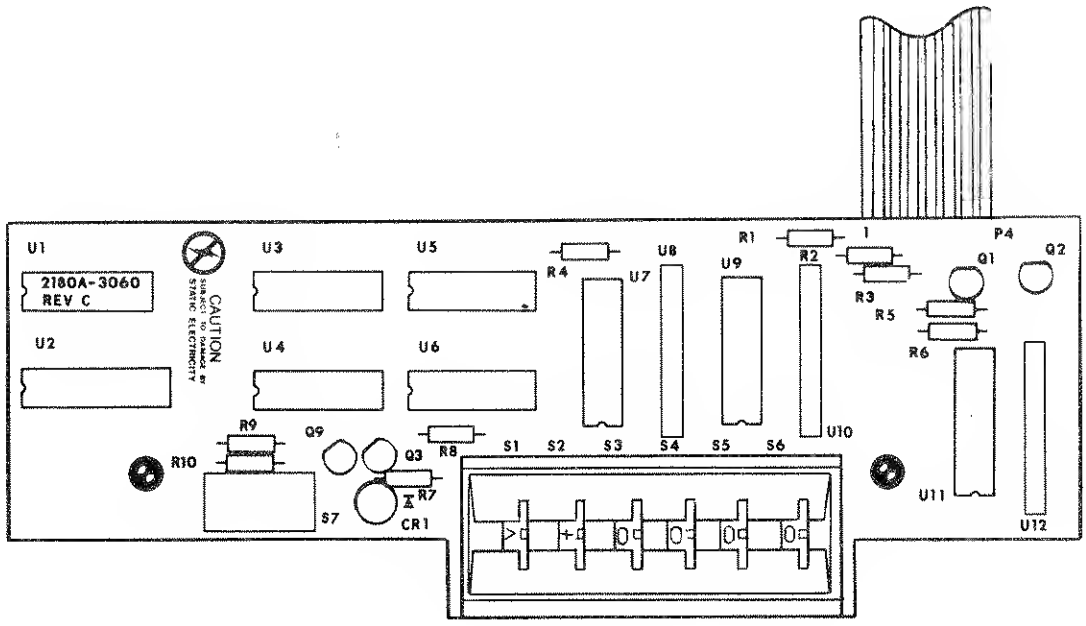


Figure 606-1. A5 Limits Option PCB Assembly

Section 7
General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

List of Abbreviations and Symbols

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
°C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
°F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^9)
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^3)
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^6)
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(-) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmable read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

Federal Supply Codes for Manufacturers

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00666
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisburg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884
Use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03506
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571
Use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06363
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06960
Eimac Div.
Varian Associates
San Carlos, California

07047
The Ross Milton Co.
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Div.
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, Massachusetts

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933
Use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

Federal Supply Codes for Manufacturers (cont)

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Minieture Lamp Products Dept
Cleveland, Ohio

08883
Nylomatic Corp.
Norrisville, Pennsylvania

08988
Use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broedcesting System
Newburyport, Minnesote

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Rectifier Division
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, Californie

12136
Philadelphie Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Div.
AMF Canada LTD.
Guelph, Ontario, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
The Budd Co. Polychem Products
Plastic Products Div.
Bridgeport, Pennsylvania

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, Californie

12954
Dickson Electronics Corp.
Scottsdale, Arizone

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, Californie

14140
Edison Electronic Div.
Mc Grey-Edison Co.
Manchester, New Hempshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, Californie

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors,
formerly Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, Californie

15898
Internetionel Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Merylend

16742
Peremount Plestics
Fabricators, Inc.
Downey, Californie

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Henover, New Jersey

18927
GTE Sylvenie Inc.
Precision Meteriel Group
Parts Division
Titusville, Pennsylvenie

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

Federal Supply Codes for Manufacturers (cont)

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical
Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp. formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, California

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey

70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnback Radio Co., Inc.
Freeport, New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303

72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynemics Div.
Torrance, Cellfornia

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74308
Piezo Crystal Co.
Carlisle, Pennsylvenie

74542
Hoyt Elect. Instr. Works
Penecook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

78854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiene

77838
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp.
Mepco Div.
A North American Phillips Co.
Norristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183
Use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Arnold Stevens, Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Vero Inc.
Garland, Texas

83058
The Carr Co., United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Div.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83478
Rubbercraft Corp.
of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, Californie

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquey-Verien, North Ceroline

88486
Plestic Wire & Ceble
Jewitt City, Connecticut

88690
Replaced by 04217

89536
John Fluke Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

Federal Supply Codes for Manufacturers (cont)

90201
Mallory Capacitor Co.
Div. of P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211
Use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737
Use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div. of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154
Use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts, Div. of
Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect.
Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

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John Fluke Mfg. Co., Inc.
3322 S. Memorial Parkway
Suite 96
Huntsville, AL 35801
(205) 881-6220

AZ, Tempe
John Fluke Mfg. Co., Inc.
2211 S. 48th Street
Suite B
Tempe, AZ 85282
(802) 438-8314

Tucson
(602) 790-9881

CA, Los Angeles
John Fluke Mfg. Co., Inc.
20902 South Bonita St.
Carson, CA 90746
(213) 538-3900

San Diego
John Fluke Mfg. Co., Inc.
4540 Kearny Villa Rd., Suite 115
San Diego, CA 92123
(619) 292-7656

Santa Clara
John Fluke Mfg. Co., Inc.
2300 Walsh Ave., Bldg. K
Santa Clara, CA 95051
(408) 727-0513

Tustin
John Fluke Mfg. Co., Inc.
15445 Red Hill Ave., Suite F
Tustin, CA 92680
(714) 838-8863

CO, Denver
John Fluke Mfg. Co., Inc.
1980 South Quebec St. #4
Denver, CO 80231
(303) 750-1222

CT, Hartford
John Fluke Mfg. Co., Inc.
Glen Lochen East
41-C New London Turnpike
Glastonbury, CT 06033
(203) 659-3541

FL, Orlando
John Fluke Mfg. Co.,Inc.
940 N. Fern Creek Ave.
Orlando, FL 32803
(305) 896-4881

GA, Atlanta
John Fluke Mfg. Co., Inc.
2700 Delk Rd., Suite 250
Marietta, GA 30067
(404) 953-4747

IA, Iowa City
(319) 354-2811

IL, Chicago
John Fluke Mfg. Co., Inc.
3740 Industrial Ave.
Rolling Meadows, IL 60008
(312) 398-0850

IN, Indianapolis
John Fluke Mfg. Co., Inc.
8777 Purdue Road
Suite 101
Indianapolis, IN 46268
(317) 875-7870

KS, Kansas City
(913) 381-9800

LA, New Orleans
(504) 455-0814

MA, Burlington
John Fluke Mfg. Co., Inc.
25 "B" Street
Burlington MA 01803
(617) 273-4674

MD, Baltimore
(301) 792-7060

Rockville
John Fluke Mfg. Co., Inc.
5640 Fishers Lane
Rockville, MD 20852
(301) 770-1570

MI, Detroit
John Fluke Mfg. Co., Inc.
33031 Schoolcraft
Livonia, MI 48150
(313) 522-9140

MN, Bloomington
John Fluke Mfg. Co., Inc.
1801 E. 79th St., Suite 9
Bloomington, MN 55420
(612) 854-5526

MO, St. Louis
John Fluke Mfg. Co., Inc.
2029 Woodland Parkway
Suite 105
St. Louis, MO 63141
(314) 993-3805

NC, Greensboro
John Fluke Mfg. Co., Inc.
1310 Beaman Place
Greensboro, NC 27408
(919) 273-1918

NJ, Paramus
John Fluke Mfg. Co., Inc.
P.O. Box 930
West 75 Century Road
Paramus, NJ 07652
(201) 262-9550

NM, Albuquerque
John Fluke Mfg. Co., Inc.
1108 Alvarado Drive N.E.
Albuquerque, NM 87110
(505) 881-3550

NY, Rochester
John Fluke Mfg. Co., Inc.
4515 Culver Road
Rochester, NY 14822
(716) 323-1400

OH, Cleveland
John Fluke Mfg. Co., Inc.
7830 Freeway Circle
Middleburg Heights, OH 44130
(216) 234-4540

Columbus
(614) 889-5715

Dayton
John Fluke Mfg. Co., Inc.
4756 Fishburg Rd.
Dayton, OH 45424
(513) 233-2238

OR, Portland
John Fluke Mfg. Co., Inc.
2700 NW 185th
Suite 2080
Portland, OR 97229
(503) 629-5928

PA, Philadelphia
John Fluke Mfg. Co., Inc.
1010 West 8th Ave., Suite H
King of Prussia, PA 19406
(215) 265-4040

Pittsburgh
(412) 261-5171

TX, Dallas
John Fluke Mfg. Co., Inc.
14400 Midway Road
Dallas, TX 75234
(214) 233-9990

Houston
John Fluke Mfg. Co., Inc.
4240 Blue Bonnet Dr.
Stafford, TX 77477
(713) 491-5995

San Antonio
John Fluke Mfg. Co., Inc.
10417 Gulfdale
San Antonio, TX 78216
(512) 340-2621

UT, Salt Lake City
(801) 268-9331

WA, Seattle
John Fluke Mfg. Co., Inc.
5020 148th Ave. N.E.
Suite 110
Redmond, WA 98052
(206) 881-6966

Service Center Areas

CA, Burbank (213) 849-4641
CA, Santa Clara (408) 727-8121
CO, Denver (303) 750-1228
FL, Orlando (305) 896-2296
IL, Chicago (312) 398-5880
MA, Burlington (617) 273-4678
MD, Rockville (301) 770-1576
NJ, Paramus (201) 262-9550
TX, Dallas (214) 233-9945
WA, Everett (206) 356-5560

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Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands. Phone (013) 673973
Litho in U.S.A. 4/84

INTERNATIONAL SALES OFFICES

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Virrey del Pino 4071
Buenos Aires, Argentina
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Australia ●
Elmeasco Instruments Pty Ltd.
P.O. Box 30, Concord, N.S.W.
Australia 2137
Tel: (2) 736-2888, TLX: (790) 25887

Elmeasco Instruments Pty Ltd.
21-23 Anthony Drive
Mt. Waverly, VIC 3149
Australia
Tel: 233-4044, TLX: (790) 36206

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Appendix 7A
Manual Change Information

INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier pcb configurations. To identify the configuration of the pcb's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table 7A-1 defines the assembly revision levels documented in this manual.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

OLDER INSTRUMENTS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in Table 7A-1.

Table 7A-1. Manual Status and Backdating Information

Ref Or Option No.	Assembly Name	Fluke Part No.	* To adapt manual to earlier rev configurations perform changes in desending order (by no.), ending with change under desired rev letter																						
			—	A	B	C	D	E	F	G	H	J	K	L	M	N	P								
A1	Thermometer Assy	469312	●	●	●	X																			
A2	Display Assy	464297	●	●	●	●	●	X																	
A3	RTD Assy	469304	●	●	●	X																			
A4	Ouput Option (-002)		●	●	1	2	X																		
A5	Limits Option (-006)		●	●	●	●	●	X																	

* X = The PCB revision levels documented in this manual.
● = These revision letters were never used in the instrument.
—= No revision letter on the PCB.

CHANGE #1, ECO -12081

On page 602-7, Table 602-5, make the following changes:

FROM: J8/Jack, Input/492314/89536/492314/2
TO: J8/Jack, Input/454058/89536/454058/2

CHANGE #2, ECO -12144

On page 602-8, Table 602-5, make the following changes:

Change TOT QTY of R24, FROM: 1 TO: Ref.

FROM: R14/Res, mf, 750k ±1%, 1/8W/271361/91637/CMF557503F/1
TO: R14/Res, mf, 1M ±1%, 1/8W/268797/91637/CMF551004F/2

DELETE: XU14/Socket, IC, 8-pin/478016/91506/308-AG39D/1

On page 8-11, Figure 8-4, make the following changes:

FROM: R14, 750k
TO: R14, 1M.

Section 8
Schematic Diagrams

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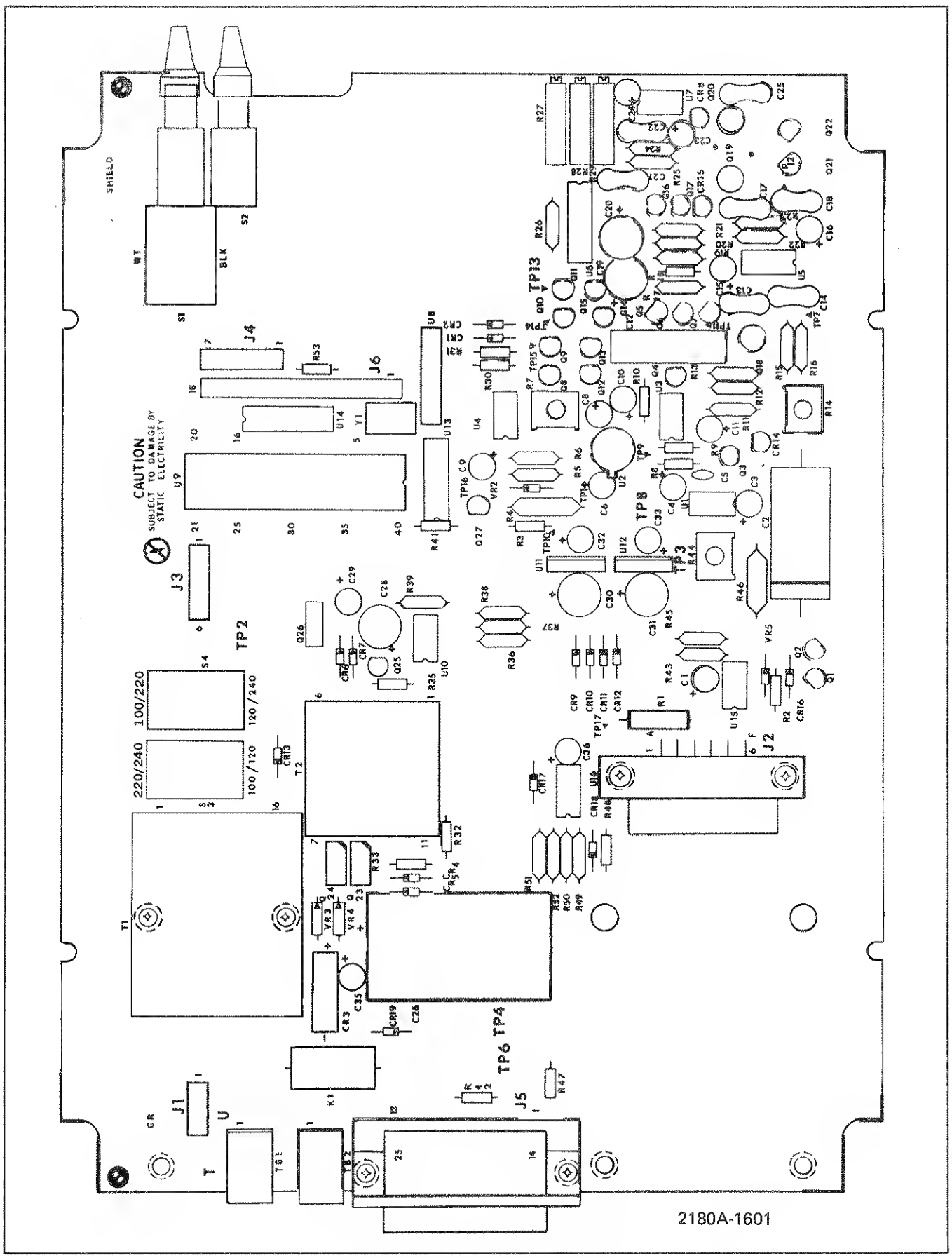

Figure 8-1. A1 Main PCB Assembly